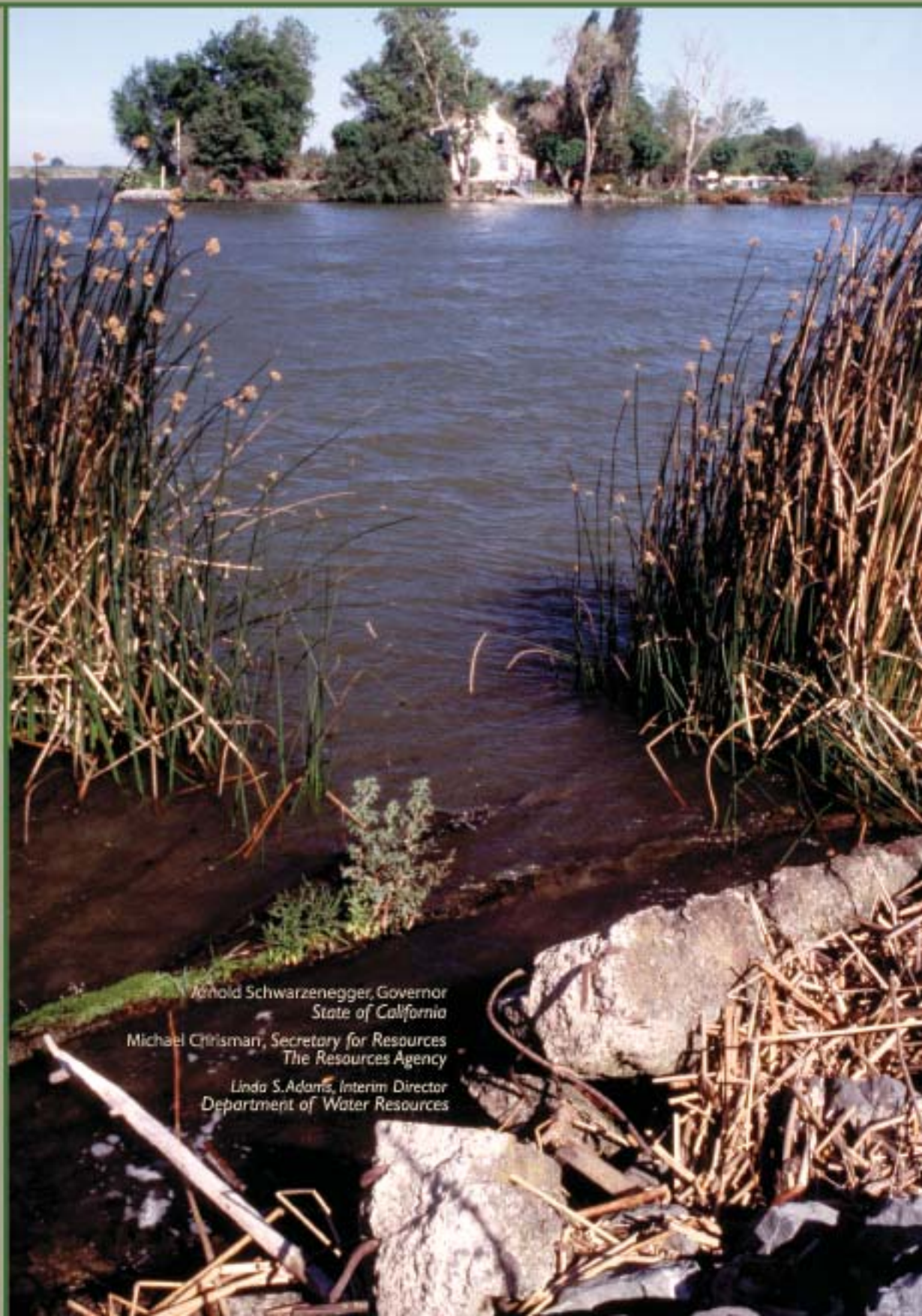
Management of the California State Water Project - Appendix E

2000 Water Operations in the Sacramento-San Joaquin Delta

Bulletin 132-01
January 2004



Arnold Schwarzenegger, Governor
State of California

Michael Chrisman, *Secretary for Resources*
The Resources Agency

Linda S. Adams, Interim Director
Department of Water Resources

Management of the California State Water Project

Appendix E
2000 Water Operations in the Sacramento-San Joaquin Delta

Bulletin 132-01
January 2004

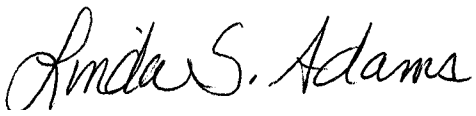
Arnold Schwarzenegger, Governor, State of California
Michael Chrisman, Secretary for Resources, The Resources Agency
Linda S. Adams, Interim Director, Department of Water Resources

FOREWORD

This is the twenty-sixth edition of Appendix E, Bulletin 132, *Water Operations in the Sacramento-San Joaquin Delta*, an annual publication written for the State Water Project contractors, resource agencies, the State Water Resources Control Board, and other regulatory agencies. Appendix E documents SWP operations in the Sacramento-San Joaquin Delta, in addition to reporting on Delta water quality. SWP operations are modified to meet water quality standards and flow requirements, as well as environmental and other operational constraints.

The Sacramento-San Joaquin Delta has often been called the focal point of water resources development in California's Central Valley. The Delta is the collection point for State Water Project water delivery to the San Francisco Bay Area, the San Joaquin Valley, and Southern California. Thus Appendix E is designed to document significant Delta events as well as to review overall performance of SWP Delta operations.

This report is based on the 2000 water year (October 1, 1999, through September 30, 2000), which was classified as *above normal* for all beneficial uses under criteria set forth in the SWRCB's Decision 1641.



Linda S. Adams
Interim Director

Table of Contents

List of Figures

List of Tables

State of California

Arnold Schwarzenegger, Governor

The Resources Agency

Michael Chrisman, Secretary for Resources

Department of Water Resources

Linda S. Adams, Interim Director

Gerald E. Johns
Acting Deputy Director

Stephen Verigin
Acting Chief Deputy Director

Tom Glover
Deputy Director

L. Lucinda Chipponeri
Deputy Director for Legislation

Peggy Bernardy
Chief Counsel

Division of Operations and Maintenance

Stephen L. Kashiwada, Chief

Richard Sanchez — Assistant to the Division Chief
Gary G. Gravier — Chief, Water and Plant Engineering Office
Daniel F. Peterson — Chief, Environmental Assessment Branch
Lawrence D. Joyce — Chief, Water Quality Section

Written by

Tim P. Smith, Environmental Scientist

Assisted by

Christine Erickson, Environmental Scientist

Editorial and Production Service

Kay Mogavero, Supervisor, Technical Publications, State Water Project Analysis Office
Cynthia Shepard, Research Writer, State Water Project Analysis Office
Therese Tynan, Research Writer, State Water Project Analysis Office
Maureen Reed, Research Writer, State Water Project Analysis Office

Cover and Layout Design by

Cynthia Shepard, Research Writer, State Water Project Analysis Office

California Water Commission

The California Water Commission serves as a policy advisory body to the Director of Water Resources on all California water resources matters. The citizen commission provides a water resources forum for the people of the State, acts as a liaison between the legislative and executive branches of State Government, and coordinates federal, State, and local water resources efforts.

Daniel M. Dooley, *Chair*, Visalia

Walter Yep, *Vice-Chair*, Piedmont

Richard W. Atwater, La Canada

Ashok Bhatt, Fremont

Ane D. Deister, Placerville

Rachel M. Dinno, Los Gatos

Martha G. Guzman, Sacramento

William J. Lyons, Jr., Modesto

Katherine Wilson Moret, Los Angeles

Executive Officer
Peter D. Rabbon

Staff Assistant
Lori Buford

Legal Counsel
Vacant

Acronyms and Abbreviations

af	acre-feet
CALFED	State and federal resource agency program coordinating Bay-Delta management activity
cfs	cubic feet per second
CL	chloride concentration
COA	Coordinated Operation Agreement
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act (PL 102-575, Title 34)
D-1379	SWRCB Water Right Decision 1379
D-1422	SWRCB Water Right Decision 1422
D-1485	SWRCB Water Right Decision 1485
D-1630	SWRCB Water Right Decision 1630
D-1641	SWRCB Water Right Decision 1641
DCC	Delta Cross Channel
Delta	Sacramento-San Joaquin Delta
DFG	Department of Fish and Game
DO	Dissolved oxygen
EC	Electrical conductivity (also referred to as specific conductance)
ESA	Endangered Species Act
EWA	Environmental Water Account
FERC	Federal Energy Regulatory Commission
FESA	federal Endangered Species Act
FRSA	Feather River Service Area
IEP	Interagency Ecological Program
ISDP	Interim South Delta Program
maf	million acre-feet
NBA	North Bay Aqueduct
NDOI	Net Delta Outflow Index
NMFS	National Marine Fisheries Service
PMI	Previous month's Eight River Index
RTM	real-time monitoring
SDIP	South Delta Improvement Program
SEW	Suisun Marsh Ecological Workgroup
SJRA	San Joaquin River Agreement
SRI	Sacramento River Index
SWP	State Water Project
SWRCB	State Water Resources Control Board
the Bureau	Bureau of Reclamation
taf	thousand acre-feet
USFWS	U.S. Fish and Wildlife Service
VAMP	Vernalis Adaptive Management Plan
X2	location of 2 ppt. isohaline

1. Summary

Water Supply Conditions

Although the water year 2000 (October 1, 1999, through September 30, 2000) started off very dry, the trend changed dramatically during mid-January 2000 as northern Sierra precipitation rose to 125 percent of average by the end of February. On May 1, 2000, the water year was forecasted to be classified as *wet*; however, by the end of the water year it actually was classified *above normal*, thus ending a record streak of 5 consecutive wet years for Northern California.

Water Supply Schedules - Actual Deliveries

The State Water Project delivered more than 4.93 maf of water to 27 long-term water contractors and 17 other agencies during 2000. SWP deliveries included 3,199,907 af of Table A water, 308,257 af of Article 21 water, 10,770 af of Article 54 flexible storage withdrawal, 4,030 af of recreation/fish and wildlife water, and 1,408,540 af to satisfy water rights settlement agreements and agreements made with SWP contractors and other agencies, including the Bureau of Reclamation.

In December 1999, the SWP water contractors were scheduled to receive 50 percent of their approved Table A requests (3.62 maf) for water year 2000. However, improving water conditions allowed the Department to increase approved Table A amounts to 70 percent on February 25, 2000. On March 14, this was increased to 100 percent. However, dryer than usual conditions after mid-March necessitated a reduction of approved Table A water to 90 percent.

State Water Project Operations

The State Water Resources Control Board adopted Decision 1641 on December 29, 1999, implementing the water quality objectives of the Sacramento-San Joaquin Delta Estuary and approving the petition to add points of diversion to the SWP and CVP. Year 2000 was the SWP's first year of operation under this decision. Though the hearings are still in progress, D-1641 replaces D-1485 as modified by Water Right Order 98-09 and conditions the water rights permits of the SWP and CVP to implement the objectives of the SWRCB's 1995 Bay-Delta Water Quality Control Plan.

On March 15, 2000, SWRCB adopted WR 2000-02 amending D-1641 and denying petitions for reconsideration of the decision. D-1641 covers Phases 1-7 of the Bay-Delta Water Rights Hearings, leaving Phase 8 (designating the responsibility of numerous water agencies for meeting the Delta outflow objectives) to be considered in early 2001.

The 1995 Bay-Delta Water Quality Plan resulted from the establishment of the 1994 State-federal Bay/Delta Accord. The Accord arose from the need for a coordinated and comprehensive ecosystem approach to management of the Bay/Delta and was designed to balance proposed SWRCB water quality standards and federal Endangered Species Act operational criteria with the need to provide water supply reliability. The U. S. Fish and Wildlife Service Delta Smelt Biological Opinion and the National Marine and Fisheries Service' Winter-run Chinook Salmon Opinion were revised on March 6

and May 17, 1995, respectively, to conform to the Bay/Delta Accord.

The CALFED Operations Group, established by the 1994 State-Federal Framework Agreement, provided guidance to the SWP and CVP for the protection of targeted fisheries. It provided this guidance based upon data gathered from real-time fisheries monitoring to effectively implement immediate decisions on export timing, Delta Cross Channel Gate operations, and temporary barrier placements. The institutional framework guiding SWP Delta operations during 2000 can be found in Chapter 4, Table 4-5.

Lake Oroville and Feather River Operations

Lake Oroville began water year 2000 with 2.4 maf (68 percent of capacity). Inflow into the reservoir during the water year totaled about 3.99 maf (86 percent of average). Lake Oroville's storage peak, reflecting its water supply for the dry season, occurred on May 29, 2000, when the storage reached 3.13 maf (89 percent of capacity). The carryover storage at the end of the water year totaled 1.92 maf (83 percent of average).

Feather River Service Area contractors took water deliveries during every month of 2000 except February and March, for a total of 1.1 maf, and returned a calculated 0.26 maf as agricultural runoff (24 percent of the total diversion).

Releases from the Oroville-Thermalito Complex augment the flow of both the Feather and Sacramento Rivers while retention of storage reduces downstream river flow. Mean monthly river-flow was augmented from June through December, with the highest augmentation occurring during July and August. River flow was reduced from January through May, with the greatest monthly reduction in February.

Delta Operations

Operation of the SWP affects the Sacramento-San Joaquin Delta in many ways, all of which are taken into account: high winter and spring inflows are reduced; outflows can be decreased to provide off-stream storage or contracted water deliveries; Sacramento River flow and Delta outflow can be augmented during the summer and early fall months; and the natural Delta circulation and outflow patterns can be altered.

During 2000, Delta conditions, as defined by the 1986 Coordinated Operating Agreement, fluctuated from balanced to excess conditions many times throughout the year. The year began and ended under balanced conditions and accumulated 224 balanced condition days.

Excess conditions days can be qualified by two outflow criteria that can limit Delta export operations, one for fish salvage and another that limits exports based on Delta inflow. During 2000, a fisheries-related restriction was in effect for about 25 percent of the 141 days designated as excess outflow days. In addition, an export restriction was in place 4 days in June, about 3 percent of the excess outflow days.

The Delta Cross Channel Gates are operated in accordance with D-1641, which lists closure periods from November 1 through June 15. During the balance of the year, when the gates typically remain open, they may be closed for short periods in response to high Sacramento River flows, water quality concerns, fishery concerns, as well as hydrodynamic and fishery experiments. During 2000, the Delta Cross Channel Gates were open for 235 days. They were open during the first half of January, and then again from late May through the end of the year, with the exception of an experimental period in October and a few 3-day closures in June and December for protection of striped bass and Chinook salmon.

Aerial view of the Delta looking up Potato Slough

Delta Outflow

D-1641 contains a calculation of Delta outflow known as the Net Delta Outflow Index and sets minimum NDOI requirements throughout the year.

All NDOI standards were met during 2000. The year's highest monthly average NDOI occurred in March with flows that averaged 103,865 cfs and the lowest monthly average NDOI occurred in September with flows that averaged 4,934 cfs.

D-1641 also contains mean monthly flow minimums at Rio Vista which are set from September through December at levels ranging from 3,000 cfs to 4,500 cfs. During 2000, the Rio Vista mean monthly flow fell to its lowest level in October averaging 5,628 cfs. All Rio Vista flow standards were met during 2000. D-1641 sets minimum monthly San Joaquin River flow objectives at Vernalis from February through June and in October. The flow minimums vary with water year type and the location of the X2 geographic isohaline located at either Chipps Island or Port Chicago. All San Joaquin River flow objectives or standards were met in 2000.

Delta Exports

D-1641 includes a standard for how much water can be diverted at Tracy and Banks Pumping Plants relative to Delta inflow. This standard can vary between 35 and 45 percent of Delta inflow for February through June, depending upon the Eight River Index, and is set at 65 percent from July through January. In 2000, the inflow/export standard was relaxed from 35 percent to 45 percent in late June to help recover exports lost during spring export curtailments related to the protection of Delta smelt. The standard was also relaxed in November to allow pumping in excess of the 65 percent standard to pump water for the Environmental Water Account. Water year 2001, which began on October 1, 2000, was the first year of operation for EWA.

Amended Winter-run Chinook Salmon and Delta Smelt Biological Opinions

The amended Winter-run Chinook Salmon Biological Opinion includes the concept of a warning (*yellow light condition*) when the combined salvage at Banks Pumping Plant and Tracy Pumping Plant rose to 1 percent of the 1999 estimated out-migrating juvenile winter-run salmon population (2,897 smolts). The yellow light condition calls for a voluntary adjustment of operations in an effort to lower salvage numbers. A salvage level of 2 percent or 5,794 smolts triggers what is called a *red light condition* and requires consultation with the Winter-run Chinook Salmon Monitoring Group.

On February 18, 2000, the yellow light level was exceeded for winter-run sized salmon and NMFS and USFWS subsequently requested the Department and the Bureau to reduce pumping in an effort to help the projects avoid reaching the red light level for winter-run salmon and reduce the salvage of Delta smelt. Exports at Banks Pumping Plant were subsequently decreased from 9,000 cfs to 6,000 cfs from February 24 through March 1, 2000. Winter run loss continued to climb in March and the red light level was exceeded on April 10. Because the VAMP period export curtailments were scheduled to take effect on April 17, no export reductions were required. The 2000 winter-run salmon restriction period ended on May 31 with the combined SWP/CVP loss totaling 5,843 smolts.

The amended Delta Smelt Biological Opinion limits the combined incidental take of Delta smelt at the pumps of the SWP and CVP. The combined yellow light limit of 400 Delta smelt is imposed year-round and is based on a 14-day running average of daily salvage. A red light level is also established that is made up of the combined cumulative salvage level and varies by month of year and water year type.

Delta smelt salvage spiked briefly in late February but the 14-day running mean remained below the 400 fish yellow light level until late May. During the VAMP period, which extended from April 17 to May 17, SWP exports remained relatively low at about 1,500 cfs, although exports were scheduled to increase following the VAMP period to about 5,500 cfs. However, actual SWP pumping during the last half of May was below 3,000 cfs due to the concern over high salvage of Delta smelt. Despite export reductions, Delta smelt salvage rose dramatically in late May. On May 21, the red light level of 9,769 Delta smelt was exceeded and the Bureau and the Department reinitiated formal consultation with USFWS as a result. By the end of May, the cumulative total of combined Delta smelt salvage exceeded 49,000 fish.

SWP exports at Banks Pumping Plant were constrained during June, but the red light level was exceeded nevertheless and totaled 49,124 by the month's end. Salvage quickly declined by the beginning of July and remained below the yellow light level throughout the month.

Sacramento Splittail Listing

USFWS listed the Sacramento splittail as threatened under the federal Endangered Species Act on February 8, 1999. During 2000, a Federal District Court judge found that the decision by USFWS to list the splittail as threatened under FESA was not reached in accordance with the law. The judge remanded the decision to USFWS for further analysis and review. The Department and the Bureau have continued to meet with USFWS in an effort to establish an incidental take statement for the operation of the SWP and CVP. Although no formal take limits were in place during 2000, the SWP and CVP continued to keep an accurate record of splittail salvage.

North Bay Aqueduct Operations

The North Bay Aqueduct conveys Delta water pumped at Barker Slough in the north Delta to contractors in Napa and Solano Counties. Deliveries to the North Bay Aqueduct totaled 41,973 af during 2000, about 1 percent of total SWP deliveries. Included in the North Bay Aqueduct deliveries were 33,773 af of Table A water, of which 30,637 af (91 percent) went to

Solano and 3,136 af to Napa (9 percent). Approximately 1,337 af of Article 21 water was also delivered to Napa and Solano; in addition, Solano received 3,921 af of non-SWP water.

Delta Water Management

The Department's South Delta Improvements Program, formerly the Interim South Delta Program, began in 1991. During most years, the SDIP installs four temporary south Delta barriers at locations on Middle River, Old River at Tracy, Old River at Head, and on Grant Line Canal. All but one of these barriers are designed to improve water levels and circulation for agricultural uses in the south Delta.

The barrier at Old River at Head prevents San Joaquin River flow from entering Old River and flowing toward SWP and CVP export facilities. The additional flow in the San Joaquin River helps guide juvenile salmon to the ocean in the spring and improves San Joaquin River dissolved oxygen concentration for salmon migrating upstream to spawn in the fall.

In spring 2000, the Old River at Head barrier was operational by April 16 and was removed by June 2. In the fall, the Old River at Head barrier was operational by October 7 and removal was completed on December 8, 2000. The other three barriers at Middle River, Old River at Tracy, and Grant Line Canal barrier stabilize channel water levels for irrigation diversions during the agricultural season.

The Middle River and Old River at Tracy barriers were operational by April 6, the installation of the Grant Line Canal barrier was completed on June 1, and all three barriers were removed by October 7, 2000.

Delta Water Quality Standards

Delta water quality is primarily regulated by salinity standards and objectives measured as either electrical conductivity or chloride concentration. These measurements reflect the impact of seawater intrusion and agricultural drainage as affected by tributary inflows, reservoir releases, and exports.

These water quality objectives and standards are designed to protect beneficial uses of Delta water categorized as municipal and industrial, agricultural, and fish and wildlife. The 1995 Bay-Delta Water Quality Control Plan contains an objective for dissolved oxygen levels (6.0 mg/L) on specified stretches of the San Joaquin River. D-1641 contains an estuarine habitat protection objective using EC (2.64 mS/cm) or flow criterion of 11,400 cfs or 29,200 cfs, depending on whether X2 is located at Chipps Island or Port Chicago, respectively. Also included are narrative objectives for salmon protection and for protection of brackish tidal marshes of Suisun Bay that implicitly list water quality measures.

During 2000, all agricultural EC standards were met at all Delta sites and all municipal and industrial chloride maximums were met as well. In addition, all fish and wildlife EC standards in the Delta and the Suisun Marsh were met.

Monitoring of the DO concentrations in the Stockton Ship Channel was conducted from August 14 through November 14, 2000, covering 14 sites from Prisoner's Point to the Stockton Turning Basin. In the late summer and early fall, prior to the installation of the Old River at Head barrier, DO concentrations in the central and eastern Stockton Ship Channel fell below the 6.0 mg/L objective due in part to low San Joaquin River flows at Vernalis and warm water temperatures in August and September. DO levels in the channel improved to greater than 7.0 mg/L after the October 7, 2000, installation of the Old River at Head barrier. The improvement in DO was likely due to a combination of factors: cooler water temperatures, increased San Joaquin River flow, a reduction in reverse flows past Stockton, reservoir releases, and increasing precipitation.

The estuarine habitat objective (X2), in place from February through June, can be met with a specified number of days in which average EC is 2.64 mS/cm or less at either Chipps Island or

Port Chicago. The X2 objective can also be met with flow criteria, which is measured as a 3-day running average of NDOI: 11,400 cfs for Chipps Island and 29,200 cfs for Port Chicago. During February 2000, X2 compliance was attained using the 3-day running average of NDOI and minimum EC at Chipps. From March through May 2000, the X2 standard was met at Port Chicago, predominantly using 3-day average of NDOI and minimum EC to a lesser extent. During June, X2 was met at the more upstream Chipps Island location, accumulating the requisite number of days where the 14-day EC average was less than 2.64 mS/cm.

Channel salinity in the Suisun Marsh is managed through the operation of the Suisun Marsh Salinity Control Gates from October 1 through May 31.

All Suisun Marsh salinity standards were met during 2000.

2. Introduction

Appendix E reports on the State Water Project's operation in the Sacramento-San Joaquin Delta as affected by Lake Oroville operations, water conditions, water demand, pumping operations, and water quality standards, as well as environmental guidelines and initiatives. Additional reports, relating to SWP operations, documenting Delta fish and wildlife studies, water quality conditions, water supply operations, and monitoring research are available by consulting the Department's Publications and Paperwork Management Office's Web site at wwwowe.water.ca.gov/information/pubs.cfm.

The State Water Project

The State Water Project is a system of reservoirs, power plants, pumping plants, and aqueducts that makes up one of the largest water and power systems in the world. The SWP begins in Plumas County where three small reservoirs make up the project's northernmost facilities — Antelope Lake, Frenchman Lake, and Lake Davis.

Downstream from these three reservoirs is Lake Oroville, the keystone of the SWP. Lake Oroville conserves water from the Feather River watershed. Contained by Oroville Dam, the tallest earth-fill dam in the Western Hemisphere, Lake Oroville is the project's largest storage facility, with a capacity of more than 3.5 maf. The map of the SWP (see Figure 2-1) identifies the major features of the SWP.

Water released from Lake Oroville flows through the Feather River and joins the Sacramento River, which drains the northern portion of California's great Central Valley and ultimately flows into the Sacramento-San Joaquin Delta. Water from the Delta is diverted by the SWP and CVP, as well as local agencies.

North Delta exports are diverted at Barker Slough Pumping Plant, providing water for Napa and Solano Counties via the North Bay Aqueduct. South Delta exports are diverted at Clifton Court Forebay where Banks Pumping Plant lifts water for delivery into Bethany Reservoir. The South Bay Pumping Plant, located at Bethany Reservoir, delivers water through the South Bay Aqueduct to Alameda and Santa Clara Counties, although most of the water from Bethany Reservoir eventually flows into the California Aqueduct for delivery to points south.

The 660-mile California Aqueduct winds along the west side of the San Joaquin Valley and transports water to O'Neill Forebay and San Luis Reservoir. The Department and the Bureau jointly own the 2 maf San Luis Reservoir, which stores both SWP and CVP water.

The water released from San Luis Reservoir flows south through the San Luis Canal, another SWP/CVP joint use facility. As the water continues to flow through the San Joaquin Valley, it has to be raised more than 1,000 feet by four pumping plants before reaching the foot of the Tehachapi Mountains.

In the San Joaquin Valley near Kettleman City, the Coastal Aqueduct serves agricultural areas west of the Aqueduct as well as municipal and industrial water users in San Luis Obispo and Santa Barbara Counties.

Figure 2-1. State Water Project

The remaining water conveyed by the Aqueduct is delivered to Southern California, but it must first cross the Tehachapi Mountains. The Edmonston Pumping Plant, located at the foot of these mountains, raises the water 1,926 feet — the highest single lift of any pumping plant in the world. The water then flows into Antelope Valley, where the Aqueduct divides into two branches — the East Branch and the West Branch.

The East Branch carries water through the Antelope Valley into Silverwood Lake, located in the San Bernardino Mountains. From Silverwood Lake, the water flows through the East Branch to Lake Perris, the southernmost SWP reservoir. The East Branch is currently being extended and will eventually carry water from the Devil Canyon Powerplant Afterbay to Cherry Valley, bringing water to Yucaipa, Calimesa, Beaumont, Banning, and other communities. Phase I is scheduled for completion in 2001, while Phase II is expected to be completed in 2015.

Water in the West Branch flows through the Warne Power Plant into Pyramid Lake in Los Angeles County; from there it flows through the Los Angeles Tunnel and Castaic Power Plant into Castaic Lake, the terminus of the West Branch.

3. Water Supply and Deliveries

Water Supply

Precipitation and Runoff

Although the May 1 forecast for water year 2000 (October 1, 1999, through September 30, 2000) was classified as *wet*, by the end of the year it was *above normal*, thus ending a record of 5 consecutive *wet* years for Northern California. This water year started off very dry, with October, November, and December 1999 accumulating only 60 percent of average precipitation in the northern Sierra. This trend changed dramatically during mid-January as northern Sierra precipitation rose to 125 percent of average by the end of February.

The northern Sierra Nevada is California's major surface water source and its rainfall is indexed by averaging rain gauge totals at eight representative regional stations (*8-Station Index*). During water year 2000, the northern Sierra 8-Station Index was 114 percent of average, very close to the 110 percent of average recorded for water year 1999. Statewide rainfall amounted to 98 percent of average, compared to 95 percent of average during water year 1999.

October began rather dry in the northern Sierra until a powerful Pacific storm during the last week of the month brought substantial precipitation to the mountains of Northern California. Due to this late-month storm, northern Sierra precipitation for October totaled just below normal. November precipitation in the northern Sierra totaled 108 percent of average, although Southern California remained quite dry. The month of December was very dry throughout the State. December precipitation in the northern Sierra amounted to only 1.5 inches compared to a historical average of 8.4 inches.

January is usually the most productive month of the rainy season and January 2000 proved no exception, providing more than 14.3 inches of precipitation in the northern Sierra by month's end. January's abundant storms pushed the statewide seasonal precipitation total to 75 percent of average and to 95 percent of average in the northern Sierra. California's water supply outlook continued to improve during February, since February's precipitation was 250 percent of average across Central California, twice the historical average statewide.

March started out wet but turned dry — northern Sierra precipitation amounted to only 55 percent of the monthly average. Statewide precipitation at the end of March was near average. April precipitation was close to average across the State, with the exception of the State's southeastern corner, which was dry. Northern Sierra precipitation totaled 3.66 inches for April (94 percent of average) while May supplied above-normal precipitation with 2.54 inches (121 percent of average). The northern Sierra precipitation during June amounted to 82 percent of average (0.82 inches) while the monthly precipitation statewide was closer to 100 percent of average.

Although July was drier than average, August and September provided above-average precipitation in the northern Sierra. An early September storm boosted statewide precipitation for the month to about 105 percent of average and to 147 percent of average in the northern Sierra.

The water year ended with statewide precipitation at 98 percent of average and the northern Sierra precipitation stations reporting 114 percent of average (56.7 inches).

Snowpack

Historically, the April to July runoff from the snowpack on the western slope of the Sierra-Cascade Range provides approximately 40 percent of California's annual usable water supply. Snowpack water content is reported in monthly Department snow survey bulletins from February to May. These measurements are used to predict the seasonal snowmelt runoff, known as the *April-July forecast.* The Sacramento Basin April-July forecast represents natural flow conditions (unaltered by upstream diversions) that would occur in the absence of constructed dams. This forecast was reported on May 1, 2000, as 102 percent of average (6.7 maf); the actual observed April-July runoff totaled 91 percent of average (6.0 maf). On May 1 both the April-July forecast and the actual observed April-July runoff for the San Joaquin River Basin were 102 percent of average (3.8 maf).

Historically, the April 1 snowpack water content has revealed the April-July snowpack at or near its peak and is the most important factor in the prediction of seasonal snowmelt runoff. In water year 2000, the snowpack peaked on March 13 and dropped to 100 percent of average on April 1. Warm, clear weather during April caused the snowmelt to progress at an above-average rate, decreasing the snowpack to 75 percent of average by May 1. During May the snowmelt continued at a greater than normal rate, peaking in late May.

Reservoir Storage

At the beginning of water year 2000, the carryover storage in the State's 156 major reservoirs was near maximum at 25.7 maf (118 percent of average) — about 2.2 maf less than the previous water year's start. At the same time, the major reservoirs of the SWP (Oroville, San Luis, and the combined southern reservoirs) held 3.8 maf, about .6 maf less than water year 1999's start. Lake Oroville, the SWP's largest storage facility, held about 2.4 maf (104 percent of average), which is approximately .43 maf less than last water year's start.

At the end of January 2000, the major SWP reservoirs had increased to about 4.0 maf compared to 4.6 maf 1 year earlier. Due to flood

Aerial view of San Luis Reservoir

control limitations, Lake Oroville storage fell slightly to about 2.35 maf. The State's share of San Luis Reservoir stood at approximately 0.91 maf compared to approximately 1.10 maf at the end of January 1999.

The abundant precipitation during January and February was followed by a drier than average March and April; however, on May 31, 2000, the State's 156 major reservoirs contained approximately 33 maf (115 percent of average), nearly the same as at this time in 1999. During the same period, the major SWP reservoirs held approximately 4.7 maf (107 percent of average) compared with approximately 5 maf on May 31, 1999. Storage at Lake Oroville on May 31, 2000, was about 3.1 maf compared to approximately 3.45 maf at this time last year; peak storage was reached on May 29, 2000, at 3,131,132 af, or 88.5 percent of designed storage capacity. This storage peak represents the amount of water available for releases later in the year. On May 31, 2000, the State's share at San Luis Reservoir stood at 762,064 af, compared with 863,254 af at the same time last year.

The State's 156 major reservoirs held about 24.2 maf (111 percent of average) at the end of the water year 2000 (September 30, 2000), compared to 25.6 maf at the end of water year 1999. SWP major reservoirs contained about 2.94 maf in comparison to approximately 3.78 maf at this time last year, and Lake Oroville contained approximately 1.92 maf (104 percent of average) compared to approximately 2.43 at the end of water year 1999.

Floodwater

During wet years, the Department occasionally accepts floodwater from the Kern River into the California Aqueduct through the Kern River-California Aqueduct Intertie under an *Agreement among the State of California, Kern County Water Agency, and the Kern River Interests for Diversions of Floodwaters through the Kern River-California Aqueduct Intertie,* dated November 18, 1975. However, in 2000, the Department did not accept any floodwater into the California Aqueduct.

Water Supply Forecast Indices

Sacramento Valley

SWRCB 's D-1641 contains a water supply forecast tool called the *Sacramento Valley 40-30-30 Water Year Classification Index* (also known as the *Sacramento Valley 40-30-30 Index)* that is used in water budget operations studies as an indicator of available water supply; this index has largely replaced its predecessor, the Sacramento River Index. SWRCB uses the Sacramento Valley 40-30-30 Index for classifying types of water years and establishing a corresponding level of protection for the Sacramento-San Joaquin Delta (Figure 3-1). This water year classification system also provides estimates of the potential water supply originating in a basin from rainfall and snowmelt runoff, groundwater accretion, and reservoir carryover storage.

The Sacramento Valley 40-30-30 Index incorporates seasonal differences in water contribution for the year and includes the prior year's conditions to establish a more reliable index of water available. The 40-30-30 factors represent the percentage weight given to the following:

(1) 40% — the forecasted or observed current year's April-through-July Sacramento Valley unimpaired runoff;
(2) 30% — the forecasted or observed current year's October-through-March Sacramento Valley unimpaired runoff; and
(3) 30% — the previous year's index with a cap of 10.

The Sacramento Valley unimpaired runoff sums the major flows into the Sacramento River Basin and is also known as the *Sacramento River Index*. Sacramento Valley unimpaired runoff during water year 2000 was 18.9 maf (104 percent of average) and the San Joaquin Valley unimpaired runoff was 5.9 maf (99 percent of average).

Since 1906, when State records began, unimpaired runoff in the Sacramento River Basin has ranged from a low of 5.1 maf in 1977 to as much as 37.7 maf in 1983.

Year classification shall be determined by computation of the following equation:

INDEX = 0.4 * X + 0.3 * Y + 0.3 * Z

Where:

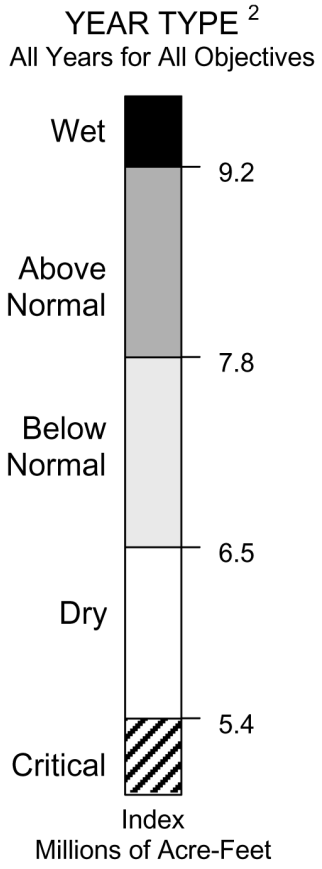
X = Current year's April – July Sacramento Valley unimpaired runoff

Y = Current October – March Sacramento Valley unimpaired runoff

Z = Previous year's index[1]

The Sacramento Valley unimpaired runoff for the current water year (October 1 of the preceding calendar year through September 30 of the current calendar year), as published in California Department of Water Resources Bulletin 120, is a forecast of the sum of the following locations: Sacramento River above Bend Bridge, near Red Bluff; Feather River, total inflow to Oroville Reservoir; Yuba River at Smartville; American River, total inflow to Folsom Reservoir. Preliminary determinations of year classification shall be made in February, March, and April with final determination in May. These preliminary determinations shall be based on hydrologic conditions to date plus forecasts of future runoff assuming normal precipitation for the remainder of the water year.

Classification	Index Millions of Acre-Feet (MAF)
Wet……	Equal to or greater than 9.2
Above Normal…….	Greater than 7.8 and less than 9.2
Below Normal……..	Equal to or less than 7.8 and greater than 6.5
Dry……	Equal to or less than 6.5 and greater than 5.4
Critical……..	Equal to or less than 5.4



[1] A cap of 10.0 MAF is put on the previous year's index (Z) to account for required flood control reservoir releases during wet years.

[2] The year type for the preceding water year will remain in effect until the initial forecast of unimpaired runoff for the current water year is available.

Figure 3-1. Sacramento Valley Water Year Hydrologic Conditions Index

The Department publishes forecasts on the Sacramento Valley 40-30-30 Index in monthly snow survey bulletins from February to May, as discussed in the section on snowpack. The May 1 Sacramento Valley 40-30-30 Index forecast determines the water year type for water quality and flow requirements contained within D-1641. Most of these water quality and flow requirements are conditioned by water year type and generally become less stringent during dryer years. On May 1, 2000, the index was forecast to be 9.2. This borderline index number put water year 2000 barely into the wet year category and thus dictated that wet year water quality and flow criteria were put in place during 2000. However, at the end of the water year, the actual Sacramento Valley 40-30-30 Index was 8.9, resulting in the 1999-2000 water year classification of *above normal* for all beneficial uses (Table 3-1).

San Joaquin Valley

D-1641 also calculates a San Joaquin River Valley 60-20-20 Index (Figure 3-2) using methods similar to those in the Sacramento Valley 40-30-30 Water Index. The San Joaquin Valley 60-20-20 Index at the 75 percent exceedence level determines the water year type for D-1641's Vernalis flow standards. The Sacramento Valley unimpaired runoff and corresponding San Joaquin Valley unimpaired runoff total are summed to produce the Eight River Index. This index is used to determine the duration of D-1641's habitat protection standard at Chipps Island and, under specific conditions, at Port Chicago from February through June. The San Joaquin River unimpaired runoff for water year 2000 (including the Stanislaus, Tuolumne, Merced, and upper San Joaquin Rivers) was 3.8 maf (96 percent of average). The San Joaquin Valley 60-20-20 Index for water year 2000 was 3.4, resulting in the classification of *above normal*.

Water Budget Process

The SWP satisfies percentages of long-term contractor's annual water requests within contractual agreements (approved Table A amounts) while assuring sufficient carryover storage is available to meet deliveries for Delta protection and emergencies in the following year. A balance between the State's water resources and contractor demand is met through the Water Budget Process.

Table 3-1. Sacramento Valley Water Year Hydrologic Conditions Index, Forecast, and Actual Runoff, during 1999-00 Water Year

Date of Forecast	Sacramento Valley 40-30-30 Index Probable Exceedence			Water Year Classification[a]	State Water Contractor Allocated Table A Delivery (% of Request)[b]
	50%	*90%*	*99%*		
December 1, 1999	8.3	6.0		above normal	50
January 1, 2000	7.4		4.9	below normal	50
February 1	7.9		5.9	above normal	70
March 1	9.5		7.9	wet	100
April 1	9.2		8.4	wet	100
May 1	9.2		8.7	wet	90
Sept. 30, 2000	8.9			Above Normal	90
Actual water year unimpaired runoff		18.9 maf (104% of average)			
April-July forecast snowmelt runoff					
May 1 forecast		6.7 maf (97% of average)			
Actual unimpaired snowmelt runoff		6.0 maf (86% of average)			

[a]Probability exceedence at the median level (50%) is used to determine D-1641 water year class.

[b]Probability exceedence at the 90% level is used to forecast SWP water supply allocations in December and thereafter the 99% level is used.

Year classification shall be determined by computation of the following equation:

INDEX = 0.6 * X + 0.2 * Y + 0.2 * Z

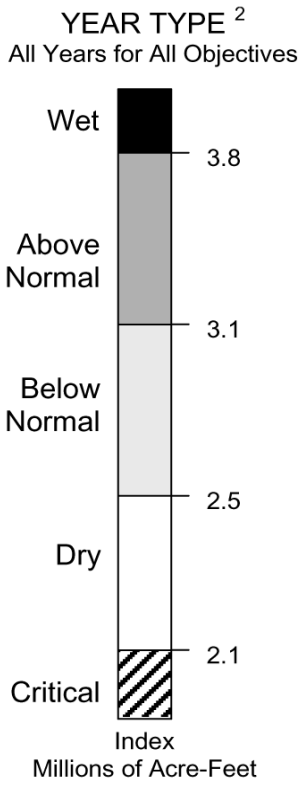
Where:
X = Current year's April – July San Joaquin Valley unimpaired runoff

Y = Current October – March San Joaquin Valley unimpaired runoff

Z = Previous year's index[1]

The San Joaquin Valley unimpaired runoff for the current water year (October 1 of the preceding calendar year through September 30 of the current calendar year), as published in California Department of Water Resources Bulletin 120, is a forecast of the sum of the following locations: Stanislaus River, total flow to New Melones Reservoir; Tuolumne River, total inflow to Don Pedro Reservoir; Merced River, total flow to Exchequer Reservoir; San Joaquin River, total inflow to Millerton Lake. Preliminary determinations of year classification shall be made in February, March, and April with final determination in May. These preliminary determinations shall be based on hydrologic conditions to date plus forecasts of future runoff assuming normal precipitation for the remainder of the water year.

Classification	Index Millions of Acre-Feet (MAF)
Wet……	Equal to or greater than 3.8
Above Normal…….	Greater than 3.1 and less than 3.8
Below Normal……..	Equal to or less than 3.1 and greater than 2.5
Dry……	Equal to or less than 2.5 and greater than 2.1
Critical……..	Equal to or less than 2.1



1 A cap of 4.5 MAF is put on the previous year's index (Z) to account for required flood control reservoir releases during wet years.

2 The year type for the preceding water year will remain in effect until the initial forecast of unimpaired runoff for the current water year is available.

Figure 3-2. San Joaquin Valley Water Year Hydrologic Conditions Index

This process makes annual forecasts based upon the following:

- reservoir capacity and storage at Lake Oroville, San Luis Reservoir, Lake Del Valle, and the four southern reservoirs;
- hydrology projections for the current year and future precipitation, runoff and groundwater accretion (Sacramento Valley 40-30-30 Index and San Joaquin River Valley 60-20-20 Index);
- operational constraints for environmental protection, recreation/fish and wildlife; and
- requests from contractors for agriculture, municipal and industrial uses, and from other agencies including the Bureau.

The Water Budget is an iterative water delivery allocation process. Initial approvals of Table A deliveries for the coming year are made in December and are based on operations studies that assume 90 percent exceedence of historical water supply (all other months assume a 99 percent exceedence). Exceedence refers to the probability that unimpaired flow will exceed the historic water supply. Forecasts are updated at least monthly using operations studies that begin in December, and approved Table A deliveries are adjusted as necessary.

SWP Water Deliveries

Monterey Agreement

The Monterey Agreement was executed by the Department and the SWP's long-term water contractors on December 1, 1994, establishing principles for amending the Department's SWP water contracts with the long-term contractors. The Agreement updated the management of the SWP by substantially revising SWP long-term contracts and their administration. The Monterey Agreement contains 14 principles that reflect the Agreement's goals to increase reliability of existing water supplies, provide stronger financial management of the SWP, and to increase water management flexibility by providing additional tools to local water agencies.

Approved Table A Deliveries

Initially the SWP contractors were scheduled to receive 50 percent of their approved Table A request of 3.62 maf. On February 25, 2000, the approved Table A amount was increased to 70 percent. Abundant storms during late February and early March allowed the Department to boost these amounts to 100 percent on March 14, 2000. Unusually dry conditions after mid-March resulted in SWP reservoir releases to maintain low salinity levels in the Delta. These unexpected storage releases impacted the 2000 water year supplies and necessitated a 10 percent reduction in the SWP contractor approved Table A water.

Actual Deliveries

In 2000, the SWP delivered over 4.93 maf to 27 of its 29 long-term contractors and to 17 other agencies. This amount is .82 taf more than the water delivered during 1999. The following is a breakdown of the 2000 SWP deliveries:

- 3,199,907 af of approved Table A water;
- 308,257 af of Article 21 water and 528 af of unscheduled water;
- 10,770 af of Article 54 flexible storage withdrawal;
- 4,030 af of SWP water for recreation, fish and wildlife; and
- 1,408,540 af of water delivered to satisfy water rights settlement agreements and agreements with SWP contractors and other agencies, including the Bureau.

Water Deliveries to Non-SWP Agencies

In 2000, the Department used SWP facilities to convey a total of 1,408,540 af of non-SWP water for various agencies according to terms of water rights and water transfer and exchange agreements.

CVP Water

SWP facilities conveyed 301,146 af of CVP water under SWRCB's D-1641, which allows the use of

Banks Pumping Plant as a joint point of diversion for water supply to CVP. Conveyance was made in accordance with agreements negotiated with the Bureau and contractors receiving water from the Bureau through SWP as follows:

- Arvin-Edison Water Storage District
- Bureau Level 4 Water
- Cross Valley Canal Contractors
- Four CVP Contractors
- Friant Water Users Authority
- Kern National Wildlife Refuge
- Musco Olive Products, Incorporated
- the Bureau
- U.S. Department of Veteran Affairs
- Westlands Water District (three separate agreements)

Water Rights Water

Water rights water is another category of non-SWP water transported through SWP facilities to long-term SWP contractors and other agencies according to terms of various local water rights agreements. In 2000, 1,101,481 af of water in this category were delivered to the Feather River, South Bay, and Southern California areas.

4. State Water Project Operations

The water operations data used in this report are preliminary and may not agree exactly with final figures; however, they are appropriate for use in this report. References to years are calendar years, except where noted.

Lake Oroville Operations

Lake Oroville operations alter seasonal flows in the Feather River and subsequently in the Sacramento River and the Sacramento-San Joaquin Delta by retaining a portion of the winter and spring runoff for release during the summer and fall. Flood control operations at Lake Oroville occur from October through June and help lessen extreme flood peaks thereby moderating flows entering the Delta (Table 4-1).

The Department and the Bureau proportionally meet Sacramento Basin and Delta water needs through SWP and CVP operations as specified in the 1986 Coordinated Operating Agreement. The application of COA operational measures is conditioned by flows into the Delta. Operations of both projects seek to balance exports with in-basin and fish and wildlife needs. Excess conditions allow greater flexibility in project operations; however, operations can be restricted during excess periods. A fish-related restriction applies when export pumping may impact endangered or threatened Delta fisheries. Exports are also restricted during excess flows to balance the export/inflow ratios within set objectives. During 2000, a fisheries-related restriction was in effect for about 25 percent of the 141 days designated "excess" outflow days. In addition, an export restriction was in place a

Beach on the Sacramento River

Table 4-1. Monthly Summary of the Oroville-Thermalito Complex Operations during 2000 (cfs)

Lake Oroville Inflow				Below Thermalito Outlet						Feather River Service Area	
				With SWP			*Without SWP*			Mean	Mean Daily
Month	Average	Low Daily	High Daily	Average	Low Daily	High Daily	Average	Low Daily	High Daily	Diver-sion	Return Flow
Jan	5,290	1,115	14,900	3,200	1,750	3,768	4,734	415	14,712	722	166
Feb	13,380	5,817	56,044	6,259	1,750	16,000	13,380	5,134	55,945	0	0
Mar	11,838	7,263	17,296	10,801	2,500	17,000	11,838	8,081	22,869	0	0
April	9,181	6,721	13,358	4,526	2,500	6,670	8,858	6,983	12,821	419	96
May	6,864	4,352	8,623	4,666	2,677	8,366	4,983	3,282	7,127	2,632	750
June	3,495	2,077	4,699	4,972	2,414	9,023	1,371	451	2,582	2,650	464
July	2,874	1,592	9,080	8,063	7,357	8,866	458	191	1,127	3,008	361
Aug	6,219	773	3,482	6,665	5,850	8,511	691	133	1,677	2,550	446
Sept	2,345	1,134	3,325	4,428	3,517	6,295	1,988	834	3,019	1,087	728
Oct	2,440	820	3,383	3,461	3,195	3,804	1,889	459	3,555	1,331	745
Nov	2,354	1,060	3,159	2,770	2,711	2,805	1,290	243	2,066	1,391	320
Dec	2,773	1,925	4,024	2,739	2,720	2,761	1,804	772	3,088	1,259	289

total of 4 days during June, about 3 percent of the excess outflow days.

During 2000, Delta conditions, as defined by the COA, fluctuated from balanced to excess conditions many times throughout the year. The year began and ended under balanced conditions and accumulated 224 balanced condition days by year's end.

Feather River Outflows

Water stored in Lake Oroville (Figure 4-1) is released through Hyatt Power Plant into the Thermalito Diversion Pool, travels through the Thermalito Diversion Dam into the Thermalito Power Canal, and then into the Thermalito Forebay. Water is released for electrical generation at the Thermalito Pumping-Generating Plant. Water then passes into the Thermalito Afterbay and is released to several local distribution systems for use in the Feather River Service Area or flows out to the Feather River via the Thermalito Afterbay river outlet. The Feather River low-flow channel is the pre-SWP river channel; it passes downstream of the hatchery and then merges with outflow from the Thermalito Afterbay river outlet, located 8.5 miles down river from the diversion dam. The 1983 Feather River Agreement with DFG sets minimum flow rates and specifies maximum temperatures on this low flow channel.

Lake Oroville releases are routinely made for flood control, water supply, fish and wildlife protection, Delta water quality needs, and in response to unusual operational events. Flows are also released from the Thermalito Diversion Dam to supply the low-flow channel of the Feather River and into a pipeline supplying the Feather River Fish Hatchery.

Lake Oroville Inflow, Releases, and Storage

Water year 2000 began with Lake Oroville storage at 2.4 maf (68 percent capacity and 104 percent of average). This represents approximately

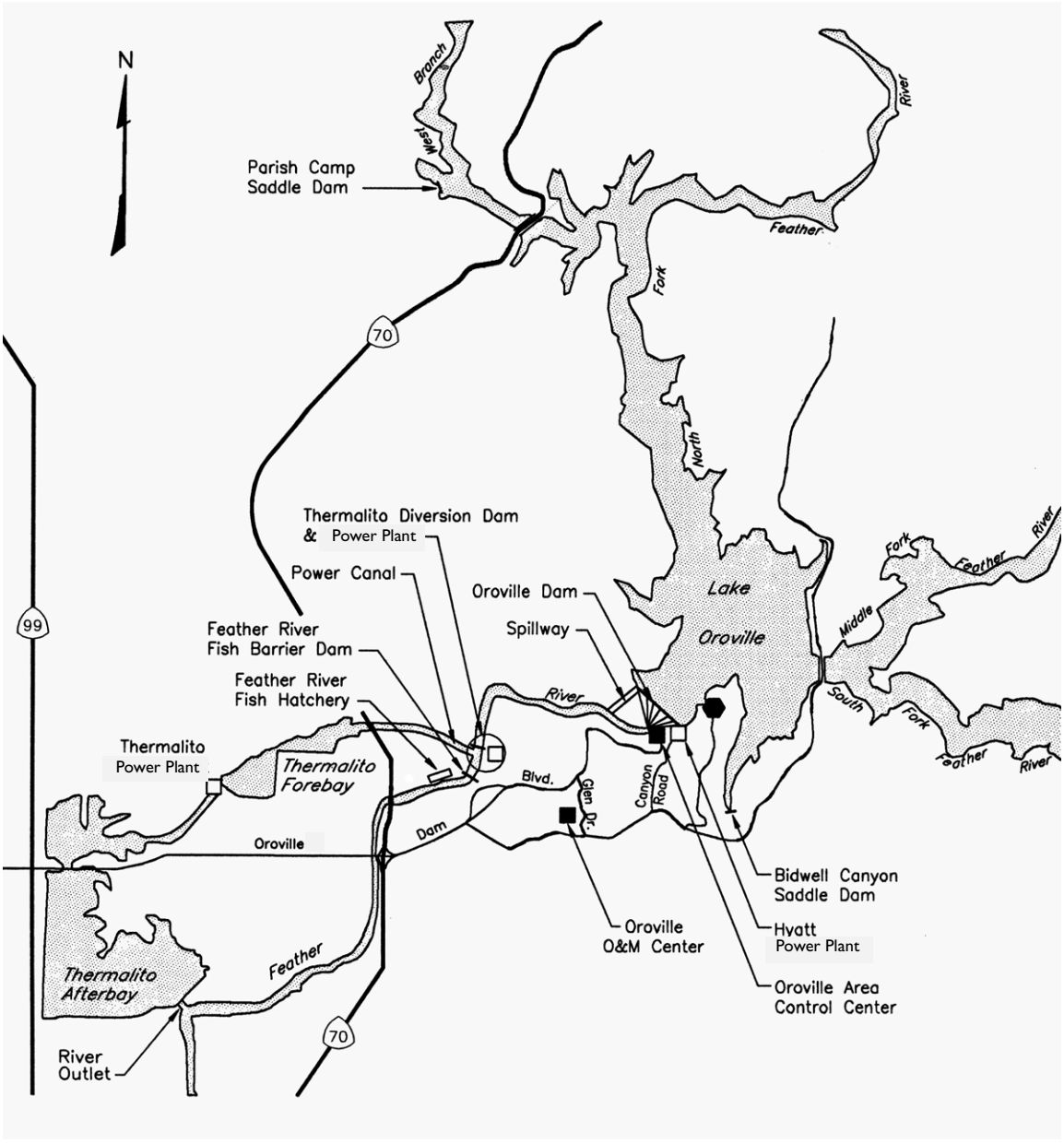


Figure 4-1. A map of the Oroville-Thermalito Complex

430 taf less than at the start of water year 1999. Lake Oroville inflow for water year 2000 was 3.99 maf (86 percent of average), somewhat less than water year 1999's total of 4.49 maf.

Water year 2000 started out rather dry — accumulated precipitation during October through December amounted to less than two-thirds of the historical average at the eight precipitation stations situated in the northern Sierra. Similar to water year 1999, heavy winter inflows into Lake Oroville did not begin until mid-January 2000. Inflows during January totaled 346 taf, and increased to 827 taf and 672 taf during February and March, respectively. Inflows to Lake Oroville began declining with a total 543 taf in April and 413 taf in May. June inflows showed a marked reduction totaling 204 taf. During November inflow averaged only 2,375 cfs per day, while August had the lowest daily inflow

rate of 2000, averaging only 773 cfs on August 21. The highest mean daily inflow rate of 56,044 cfs occurred on February 14.

Minimum storage at Lake Oroville occurred on December 30, 2000, at 1,724,943 af, about 49 percent of design capacity. Lake Oroville reached its peak storage on May 29, 2000, reaching 89 percent of capacity (3,131,132 af). Lake Oroville began 2000 with storage at approximately 62 percent capacity. As a result, early winter storage increases were not hampered by the need to provide flood control reservation space and levels began increasing in mid-January. A sharp increase occurred in mid-February as inflows averaged nearly 58,000 af per day over a 5-day period, which extended from February 13 to 17. The storage spike of mid-February foretold a continued steady climb towards the storage peak of May 29. Shortly after this May 29 peak, storage began a slow, steady decline that essentially continued to the end of the calendar year. Lake Oroville's carryover storage at the water year's end was 1.92 maf (83 percent of average) (Table 4-2 and Figure 4-2). All Feather River flow and temperature criteria set in the 1983 DFG Feather River Agreement with the Department were met in 2000.

Feather River Service Area Diversions

Water deliveries are made to FRSA from the Oroville-Thermalito Complex for local water agencies and to satisfy water rights settlements that predate the construction of the SWP. The 2000 FRSA diversions totaled 1.09 maf and occurred during all months except February and March. FRSA returns water to the Feather River in the form of agricultural runoff and in 2000, the calculated return totaled 0.26 maf, or about 24 percent of the total diversion. The greatest amount of water was diverted during the months of May to August.

Effects of the Oroville-Thermalito Complex Water Operations on Feather and Sacramento River Flow

The operation of the Oroville-Thermalito Complex affects flows in the Feather and Sacramento Rivers. However, it takes approximately 2 days for the impact to be seen in the Sacramento River below Freeport.

The Department computes a "with SWP" (current project) and "without SWP" (pre-project) flow to describe the effects of Oroville-Thermalito Complex operation on both rivers as defined below. Reservoir evaporative water losses are not included in these computations.

(1) The sum of Oroville-Thermalito Complex releases to the Feather River plus the estimated FRSA return flows defines the *with SWP* flow.
(2) The pre-project *without SWP* flow is calculated as Lake Oroville inflow minus deliveries to FRSA (up to the limit of inflow), plus return flows from FRSA.
(3) The difference between the *with SWP* and *without SWP* flows is the approximated effect of SWP operations on Feather River flows.

Currently, most diversions to FRSA in the summer months exceed calculated pre-project Feather River flows. Under pre-project conditions *without SWP*, FRSA diversions from the Feather River could not have exceeded river flow. As a result, the *without SWP* average monthly flow cannot be computed directly from Table 4-2 summary data.

Augmentation

Sacramento and Feather River flows are considered to be augmented when the water released from the Oroville-Thermalito Complex exceeds the calculated pre-project flows. Feather River flow is often augmented as a result of Oroville-Thermalito releases executed for both evacuation of adequate flood control storage capacity in Lake Oroville and to meet conditions specified in the 1983 Feather River Agreement with DFG. Water from Lake Oroville is also released to meet Delta water quality and flow standards, ESA criteria, and SWP and non-SWP export needs at Banks Pumping Plant.

Table 4-2. Lake Oroville Storage during Water Year 1999-00

Date	maf	Percent of Capacity[a]	Percent of Historic Average
October 1, 1999	2.40	68	104
February 1, 2000	2.35	66	97
March 1, 2000	2.77	78	107
April 1, 2000	2.80	79	99
May 1, 2000	3.10	88	105
WY peak on May29[b]	3.13	89	103
September 30, 2000	1.92	54	83

[a]Lake Oroville has a capacity of 3,537,580 af
[b]Peak daily storage during Water Year 2000 equaled 3,131,132 af

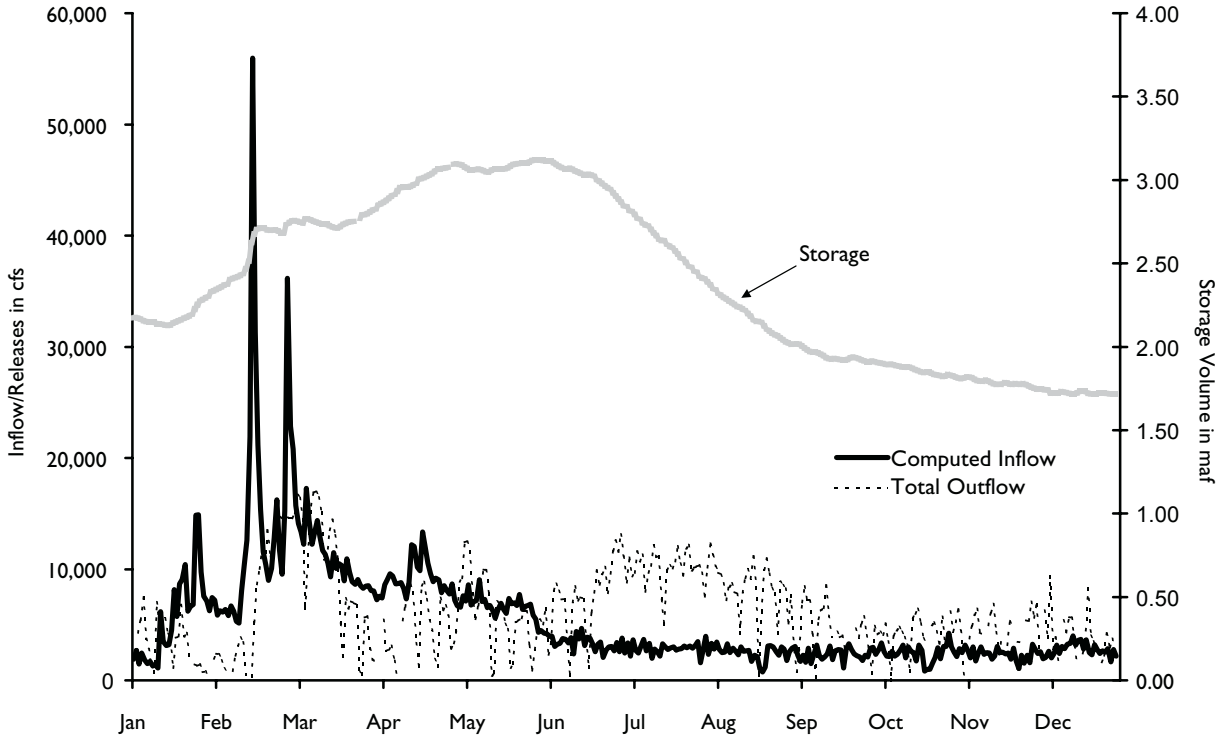


Figure 4-2. Lake Oroville inflow, releases, and storage during 2000

During 2000, the operations of the Oroville-Thermalito Complex augmented Sacramento and Feather River flows from June through December; the highest flow augmentation occurred during July and August.

Reduction

Feather and Sacramento River flows are considered reduced (designated by a negative value) when flow levels fall below pre-project conditions. Flows were reduced in 2000 by project operations during high inflow periods occurring from January through May. Monthly reductions were greatest during February (Tables 4-3 and 4-4, Figure 4-3).

Table 4-3. Effects of SWP Oroville Operations on Feather and Sacramento River Flow during 2000 (cfs)[a]

	Months with Mean Augmentation			Months with Mean Reduction			
	Mean (+)	*Minimum Augmentation*	*Maximum Augmentation*		*Mean (-)*	*Minimum Reduction*	*Maximum Reduction*
June	3,601	-129	8,099	January	-1,535	3,290	-12,914
July	7,604	6,675	8,603	February	-7,122	5,540	-53,841
August	5,974	4,675	8,029	March	-1,037	5,953	-6,869
September	2,440	537	5,101	April	-4,332	-423	-7,086
October	1,573	-234	3,049	May	-317	3,699	-2,882
November	1,480	667	2,509				
December	936	-360	1,948				

[a]Comparison of present river flows that would have occurred without Oroville Dam.

Table 4-4. Monthly Summary of Sacramento River Flows during 2000 (cfs)

	At Freeport			At Rio Vista		
	Mean	*Low Daily*	*High Daily*	*Mean*	*Low Daily*	*High Daily*
Jan	24,399	13,690	50,545	18,685	8,025	44,995
Feb	62,397	34,574	87,670	54,409	30,564	78,317
Mar	58,566	27,095	81,101	53,560	24,596	73,064
Apr	26,654	21,784	34,271	22,258	18,053	29,625
May	20,405	15,269	27,455	15,671	8,388	23,321
Jun	16,022	13,413	19,301	8,154	6,275	9,791
Jul	20,807	19,576	22,027	11,155	10,264	11,976
Aug	17,645	15,509	21,084	9,177	7,684	11,545
Sep	15,137	12,555	18,416	7,822	6,374	9,887
Oct	11,734	10,369	14,245	5,628	4,817	7,425
Nov	12,346	10,893	14,428	6,443	5,354	7,762
Dec	13,745	13,034	15,856	7,727	7,199	9,201

Note: Flows between Freeport and Rio Vista may be diminished by diversions into the Delta Cross Channel or into Georgiana Slough.

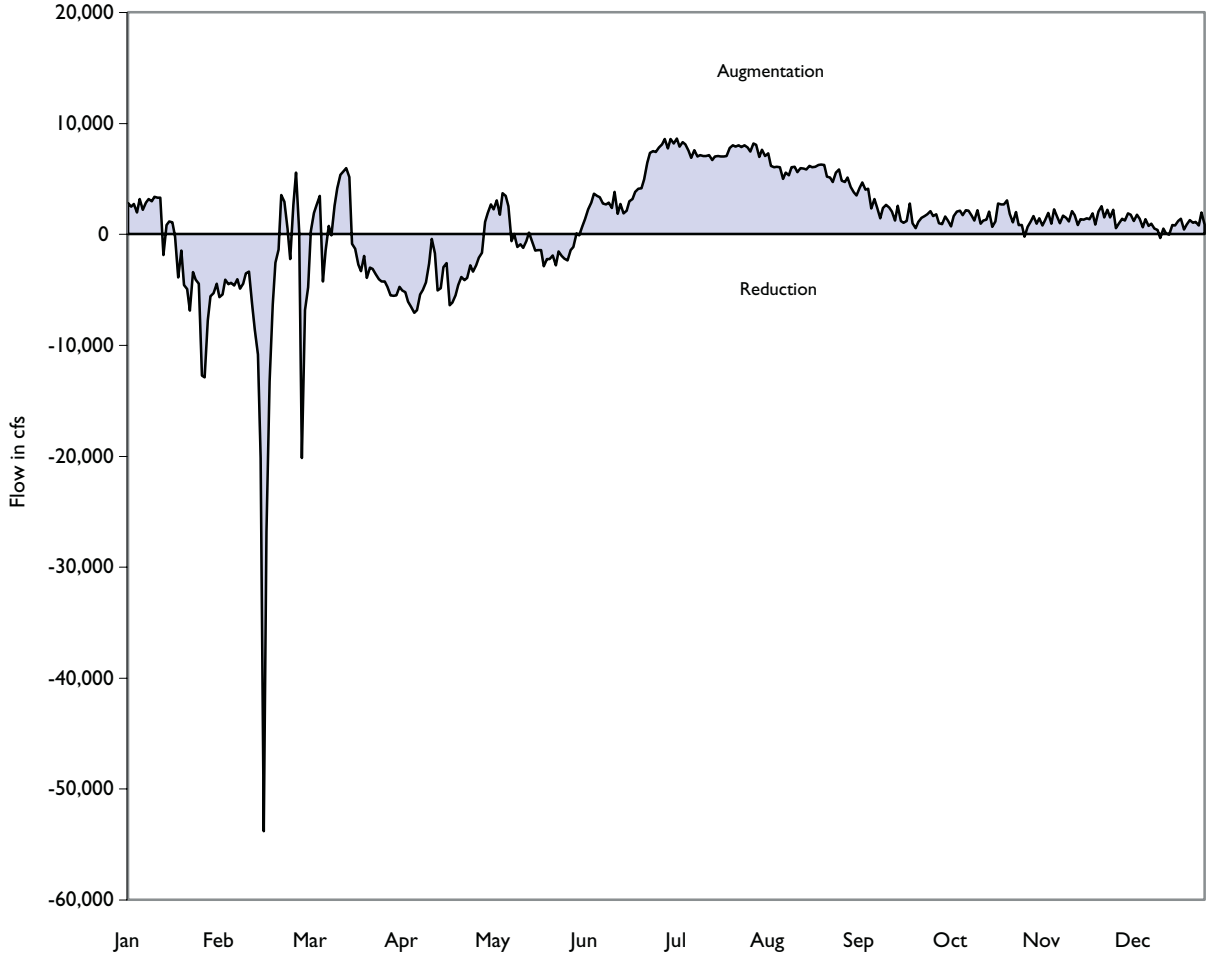


Figure 4-3. Effect of SWP operations on Feather River flow during 2000

SWP Delta Operations

Water levels and flow in the Sacramento-San Joaquin Delta are subject to sizable daily tidal fluctuations. Tidal changes in the Pacific Ocean cause flow reversal twice daily throughout much of the Delta. Flow in the Delta can also be affected by SWP and CVP pumping. SWP's Banks Pumping Plant begins the export of Delta water from Clifton Court Forebay into the California Aqueduct and nearby South Bay Aqueduct. Tracy Pumping Plant, located near Banks Pumping Plant, begins exports of CVP water into the Delta-Mendota Canal. The SWP also pumps water from the northern Delta at Barker Slough Pumping Plant into the North Bay Aqueduct.

State Water Project Operational Criteria

The Sacramento-San Joaquin Delta is an estuary and a navigable waterway subject to many State and federal laws that are designed to protect water quality, wetlands, anadromous and native fisheries, migratory birds, and threatened and endangered species. Table 4-5 lists the agreements, decisions, opinions, and rules that make up the institutional framework for SWP operations in the Sacramento-San Joaquin Delta. These operational criteria have a significant impact on water diversion from the Sacramento-San Joaquin Delta. With the exception of newly adopted criteria, the operational criteria will not be described further in this report. For additional information on these criteria, please refer to Bulletin 132-98 Appendix E.

Table 4-5. Institutional Framework for SWP Operations in the Sacramento-San Joaquin Delta during 2000

- Agreement between DWR and DFG concerning operations of the Oroville Division of the SWP for the management of fish and wildlife - 7/67 and 8/83
- U.S. Army Corps of Engineer's Section10 permit and Public Notice 5820-A 10/81. Permitted operations of Banks Pumping Plant.
- Agreement between the United States of America and State of California for Coordinated Operation of CVP and the SWP (COA) - 1986
- Agreement between DWR and DFG to offset direct fish losses in relation to the Banks Pumping Plant (Four Pumps Agreement) - 12/86
- Suisun Marsh Preservation Agreement signed by the Department, the Bureau, DFG, and SRCD - 3/87
- Central Valley Project Improvement Act (PL 102-575, Title 34) (CVPIA) - 9/92
- NMFS Biological Opinion for Winter-run Salmon, long-term, 2/93. Amended 5/95 to conform to Bay/Delta Accord
- USFWS Formal Consultation on the 1994 Operation of the CVP and SWP: Effects on Delta Smelt (Long-term Biological Opinion) - 1/94, amended 3/95 to conform to the Bay/Delta Accord
- Framework Agreement between the Governor's Water Policy Council of the State of California and the Federal Ecosystem Directorate - 6/94
- Monterey Agreement - Statement of Principles by the State Water Contractors and the State of California Department of Water Resources for potential amendments to the State Water Supply contracts - 12/94
- Principles For Agreement On Bay-Delta Standards Between The State Of California and The Federal Government (Bay-Delta Accord) - 12/94
- Formal Consultation and Conference on Effects of Long-Term Operation of the Central Valley Project and State Water Project on the Threatened Delta Smelt, Delta Smelt Critical Habitat, and Proposed Threatened Sacramento Splittail, USFWS - 3/95
- Water Quality Control Plan for the San Francisco Bay /Sacramento-San Joaquin Estuary (1995 Bay-Delta Plan) 5/95
- Principles For Agreement On Bay-Delta Standards Between The State Of California And The Federal Government (Bay-Delta Accord) extended for 1 year -12/97
- SWRCB Water Right Decision 1641 - Conditions the water rights permits of the SWP and CVP to implement the water quality objectives of the 1995 Bay-Delta Water Quality Control Plan - 12/99

Year 2000 is the first time SWP operated under SWRCB's D-1641. D-1641, adopted in December of 1999, replaces D-1485, as modified by Water Right Order 98-09 and conditions the water rights permits of the SWP and CVP to implement the water quality and flow objectives contained within SWRCB's 1995 Bay-Delta Water Quality Control Plan. The following amendments are included in the decision:

- approval of a joint petition of the Department and the Bureau to add points of diversion to the SWP and CVP in the southern Delta. The decision further approves a Bureau petition to change CVP places and purposes of use.
- expansion of the responsibilities of the Department and the Bureau to meet the southern Delta salinity objectives previously listed in the 1995 Bay-Delta Water Quality Control Plan. Prior to D-1641, no water rights holder had a responsibility under a water right permit to meet these salinity objectives.
- removal of the burden of meeting salinity standards at two locations in the western Suisun Marsh [Morrow Island (S-35) and Ibis Club (S-97)] for both the Department and the Bureau. D-1641 further allows some variability in meeting the Suisun Marsh salinity standards.
- approval of the San Joaquin River Agreement for a period of 11 years. SJRA

facilitates the implementation of the Vernalis Adaptive Management Plan which is designed to gather information on the effects of exports and San Joaquin River flows on the survival of fall-run Chinook salmon.

The balance of the permit amendments in the decision involves the recognition of various Memorandums of Understanding, stipulations, and agreements among various groups, including the Department, that seek to resolve questions of responsibility for meeting the water quality objectives contained within the Bay-Delta Water Quality Control Plan.

On March 15, 2000, SWRCB adopted Water Rights Order 2000-02 amending D-1641 and denying petitions for reconsideration of the Decision. D-1641 covers Phases 1-7 of the Bay-Delta Water Rights Hearings, leaving Phase 8, the allocation of responsibility for meeting the Delta outflow objectives, to be considered in early 2001.

The CALFED Bay-Delta Program

The CALFED Bay-Delta Program began in 1995 to address environmental and water management problems associated with the Bay-Delta. It is a cooperative effort among State and federal agencies, urban and agricultural water users, fishing interests, environmental organizations, business interests, and others, with a common goal of finding solutions to the problems facing the Bay-Delta. The Department has been an enthusiastic proponent of CALFED, recognizing it as a means of developing the State's water resources to the benefit of both the public and the environment, as well as fulfilling the water obligations of the SWP.

CALFED released the *Draft Programmatic Environmental Impact Statement/Environmental Impact Report for the Bay-Delta Program* on June 25, 1999, followed by a 90-day public comment period. On July 21, 2000, CALFED released the final EIS/EIR.

In June of 2000, a plan was published to fix the Delta and address its future water challenges (*California's Water Future: A Plan for Action).* This plan was formalized in the CALFED Record of Decision issued on August 9, 2000. The Department has taken a prominent role in the implementation of the CALFED plan participating in programs relating to water storage, Delta water

The Suisun salt marsh provides important habitat to the endangered salt marsh harvest mouse.

conveyance, Delta levees, watershed management, water use efficiency, and water quality.

During 2000, CALFED activities included the development of a contingency plan to reduce critical water shortages, continuation of Integrated Storage Investigations operations, establishment of a financial plan and operating principles for the Environmental Water Account, and identification of components for improvement in the South Delta.

Delta Cross Channel Gate Operations

Sacramento River flow at Walnut Grove in the northern Delta (between Freeport and Rio Vista) can be diminished by water diversion into the Delta Cross Channel (gated diversion constructed and operated by the Bureau) or into Georgiana Slough, a natural channel just downstream of the Delta Cross Channel.

The Ryde Hotel, near Walnut Grove, was built in 1927. It was an opulent establishment that served as a riverboat way station, complete with a beauty salon and barbershop. It is still in business today.

DCC Gates are operated in response to a variety of criteria relating to flow, water quality, and fisheries. D-1641 calls for closure of the gates from February 1 until May 20, and they may be closed for a total of 14 days during May 21 through June 15. From November through January, the gates may also be closed for a total of 45 days for fisheries protection, as requested by USFWS, NMFS, and DFG. During all these periods, the CALFED Operations Group determines timing and duration of gate closures.

In 2000, the DCC Gates were open for 235 days (Figure 4-4). They were open during the first half of January with Sacramento River flows remaining below 25,000 cfs and closed on January 16 as precipitation quickly boosted those flows. The gates were opened again on May 26 and essentially remained opened throughout the balance of the calendar year. There were, however, some closures during this 7-month period. A fisheries experiment during the first 3 weeks of October involved closing the gates on the ebb tide and opening them on the flood tide while monitoring fish movement and salinity conditions. The final phase of the experiment began on October 20 and originally involved complete closure of the gates for 3 weeks. Growing concerns over water quality degradation resulted in a change in this gate closure period so that the gates were operated half-time tidally (i.e., the gates were closed 75 percent of the time). There were also two 3-day closures in June for the protection of migrating striped bass, and one 3-day closure in late December to protect out-migrating juvenile Chinook salmon.

Flow Standards

D-1641 sets flow rate objectives for the San Joaquin River at Vernalis, the Sacramento River at Rio Vista, and the Delta using the Net Delta Outflow Index. Real-time fisheries monitoring is

a tool used in determining the timing and duration of the San Joaquin River at Vernalis flow standard during April, May, and October. The 2000 Real-time Monitoring Program sampled fish 5 days per week at some 37 Delta sites from April 1 through July 31. The RTM Data Summary Team provided a synopsis of the monitoring results, and recommendations to the CALFED Operations Group for making water project operational decisions. All flow objectives were met during 2000.

Vernalis Flow. Vernalis is located at the southernmost boundary of the Delta near the confluence of the Stanislaus and San Joaquin Rivers. The *Vernalis flow* represents the San Joaquin River's contribution to Delta inflow.

The Vernalis minimum monthly flow objective changes with water year type and is also dependant on whether the Habitat Protection Standard (X2) is met at either Chipps Island or further downstream at Port Chicago. The San Joaquin Valley 60-20-20 Index at the 75 percent exceedence level determines the Vernalis water year type. During water year 2000, X2 compliance was attained at Port Chicago from March through May, requiring the higher base flow objective at Vernalis during those months. During February and June, X2 compliance was met at the more upstream Chipps Island; as a result, Vernalis flows were required to meet the lower base flow objective for those months.

During wet years and above-normal years, a base flow minimum is set at 3,420 cfs (monthly or partial monthly average) for the San Joaquin River at Vernalis from February 1 through April 14 and May 16 through June 30 when X2 is met at Port Chicago. An additional base flow minimum of 1,000 cfs applies during October, with the addition of 28,000 af pulse/attraction flow to bring San Joaquin River flows up to 2,000 cfs. The CALFED Operations Group may also determine timing and duration of these flows based on real-time fisheries monitoring.

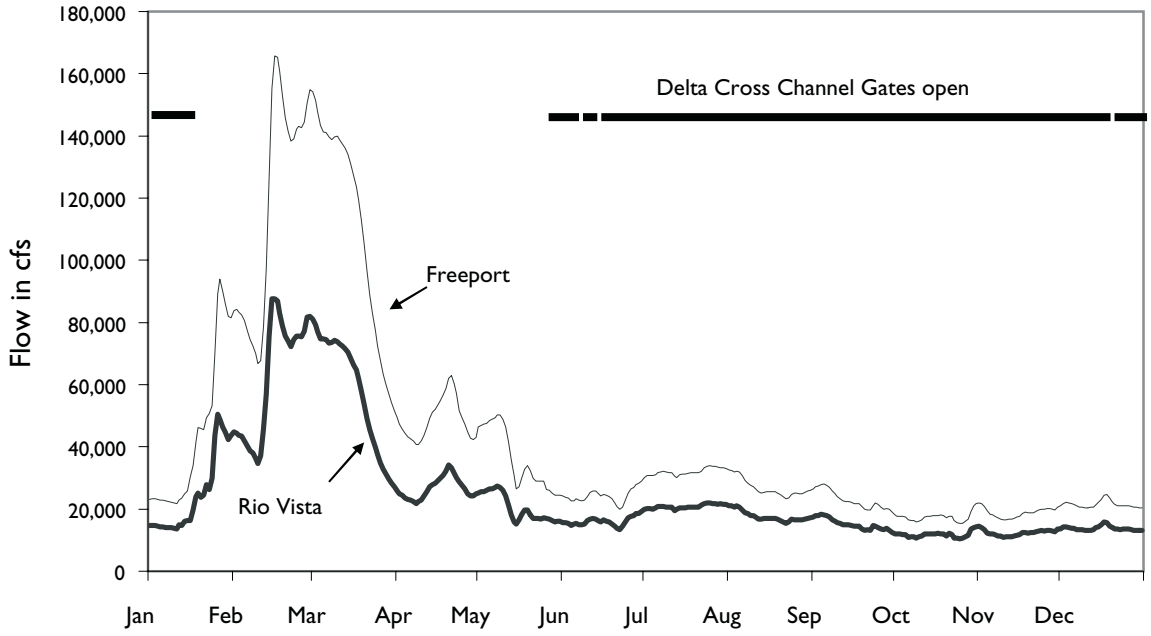


Figure 4-4. The above figure shows Sacramento River flows and Delta Cross Channel status during 2000. From September 28 through November 8 (not indicated in the figure above), the DCC Gates were only partially open as part of an experiment to examine the effect on fish, flows, and water quality.

This Vernalis base flow objective helps to maintain a positive outflow through the central Delta while helping to minimize reverse flow conditions and fish entrainment at the export pumps. The 7-day average must not be less than 20 percent of period mean. During 2000, the Vernalis monthly flow averaged 7,321 cfs, 12,372 cfs, and 4,709 cfs for February, March, and the first half of April, respectively. Flows averaged 4,085 cfs during the latter half of May and were 2,911 cfs during June. October flows averaged 2,808 cfs. All Vernalis base flow requirements were met during 2000 (Table 4-6, Figure 4-5). D-1641 includes a spring pulse flow objective for the San Joaquin River at Vernalis, also conditioned by the San Joaquin Valley 60-20-20 Index and the X2 compliance location. This spring pulse flow aids in the transport of Delta smelt out of the southern and central Delta into Suisun Bay during their critical spawning period. The pulse flow's timing and duration is based on real-time fisheries monitoring to coincide with fish migration in the San Joaquin River and its tributaries.

The spring pulse flow period contained within D-1641 coincides with the VAMP spring experimental period. VAMP export and flow criteria are recognized by SWRCB as an alternative to spring pulse flow criteria contained within D-1641. The Department and the Bureau are participants in the San Joaquin River Agreement, which facilitates VAMP. In spring 2000, the SWP and CVP opted to use the spring pulse flow and export targets included in VAMP. This resulted in a flow target of 5,700 cfs, while actual flows averaged 5,869 cfs during the April 17 to May 17 pulse flow period.

Rio Vista Flow. Sacramento River flow at Rio Vista can be reduced by upstream diversions via the Delta Cross Channel, natural channels, and

Table 4-6. San Joaquin River Flow Objectives Measured at Vernalis during 2000 (cfs)

	Objectives and Flows	
Period	*Monthly or Period Mean >*[a]	*Actual Monthly or Period Mean*
Base Flow[b]		
Feb	3,420 or 2,130	7,321
Mar	3,420 or 2,130	12,372
Apr 1-14	3,420 or 2,130	4,709
May 16-31	3,420 or 2,130	4,085
Jun	3,420 or 2,130	2,911
Oct[c]	2,000	2,808
Pulse Flow[d]		
Apr 17 - May 17	5,700	5,869
Combined exports limited by the Vernalis Adaptive Management Program[d] The Department is a participant in the San Joaquin River Agreement which facilitates VAMP.		
	Export Limit	*Combined Exports*
Apr 17 - May 17	2,250	2,249

Additional base flow criteria:

[a]Higher flow objective applied February through May as the 2 ppt isohaline (X2) objective was met at Port Chicago. During June, the lower flow objective applied as the X2 objective was met at Chipps Island.

[b]7-day running average shall not be less than 20% below the flow rate objective.

[c]1,000 cfs plus an additional 28,000 af pulse/attraction flows to bring monthly average up to 2,000 cfs; timing is determined by CALFED Operations Group.

[d]SWRCB allows use of alternative San Joaquin flow and south Delta export targets contained within the Vernalis Adaptive Management Program.

by Delta consumptive use, in addition to being opposed by tidal flow. D-1485 previously required year-round flow minimums at Rio Vista, but the 1999 adoption of D-1641 replaced D-1485, thus eliminating the year-round flow minimums. D-1641 does set Rio Vista mean-monthly flow minimums of 3,000 cfs, 4,000 cfs and 4,500 cfs, for September, October, and November-December, respectively, for wet and above-normal years. Flow minimums become less during below-normal, dry, and critical years. During these compliance periods, the 7-day running average daily mean cannot be more than 1,000 cfs below the required monthly average. During 2000, the Rio Vista mean monthly flow fell to its lowest level in October, averaging 5,628 cfs. All Rio Vista flow standards were met during 2000 (Table 4-7, Figure 4-6).

Net Delta Outflow Index. Actual measurements of net Delta outflow are impractical because of the effects of tide. However, since net outflow is one of the primary factors controlling Delta water quality, the Net Delta Outflow Index was developed as part of the Bay/Delta Accord. NDOI is derived using flows from the Sacramento River, the San Joaquin River at Vernalis, the Yolo Bypass, the Eastside stream system (the Mokelumne, Cosumnes, and Calaveras Rivers), some miscellaneous creeks, sloughs, and canals, and discharges from the Sacramento Regional Wastewater Treatment Plant. Major Delta exports and an estimated in-Delta water use factor is then deducted from the cumulative inflow total to produce the index.

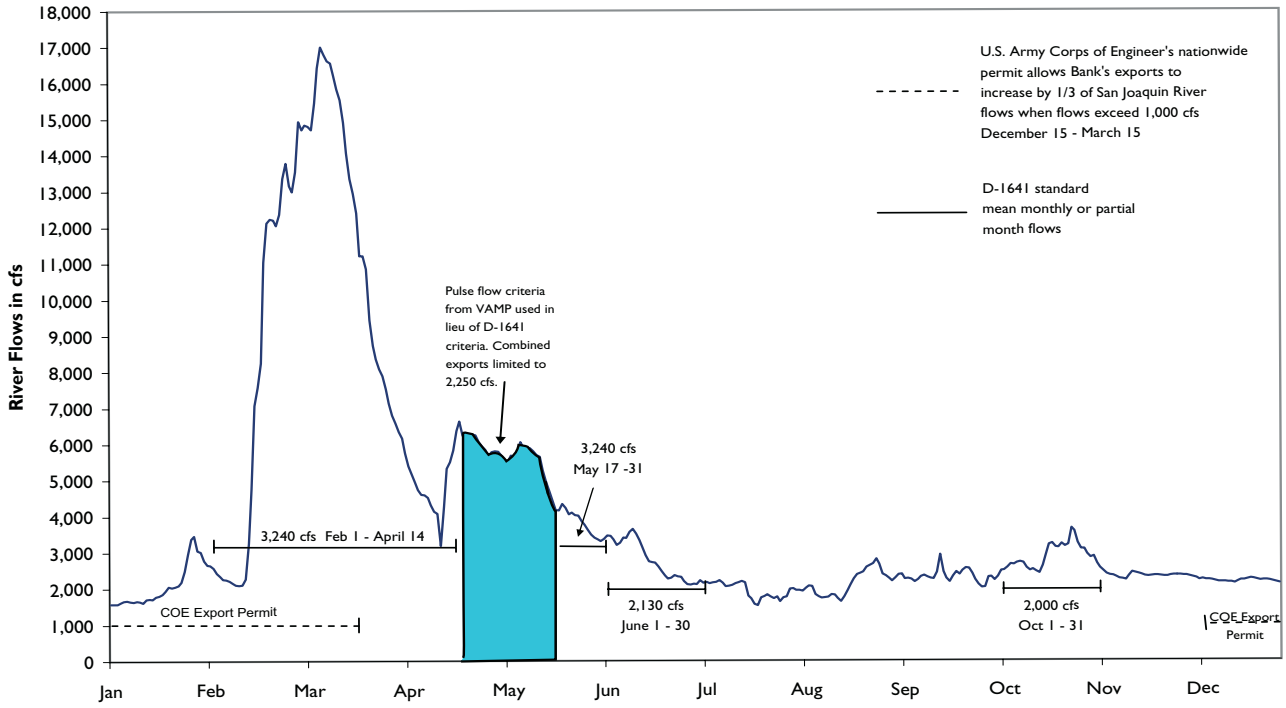


Figure 4-5. San Joaquin River flow standard and operational criteria at Vernalis, 2000

Table 4-7. Sacramento River Standards at Rio Vista for Wet Year 2000 (cfs)

	D-1641 Standards	Actual Flows	
Month	*Monthly average*[a]	*Lowest daily flow*	*Monthly average flow*
Sep	3,000	6,374	7,822
Oct	4,000	4,817	5,628
Nov	4,500	5,354	6,443
Dec	4,500	7,199	7,727

[a]7-day running average shall not be less than 1,000 cfs below monthly standard.

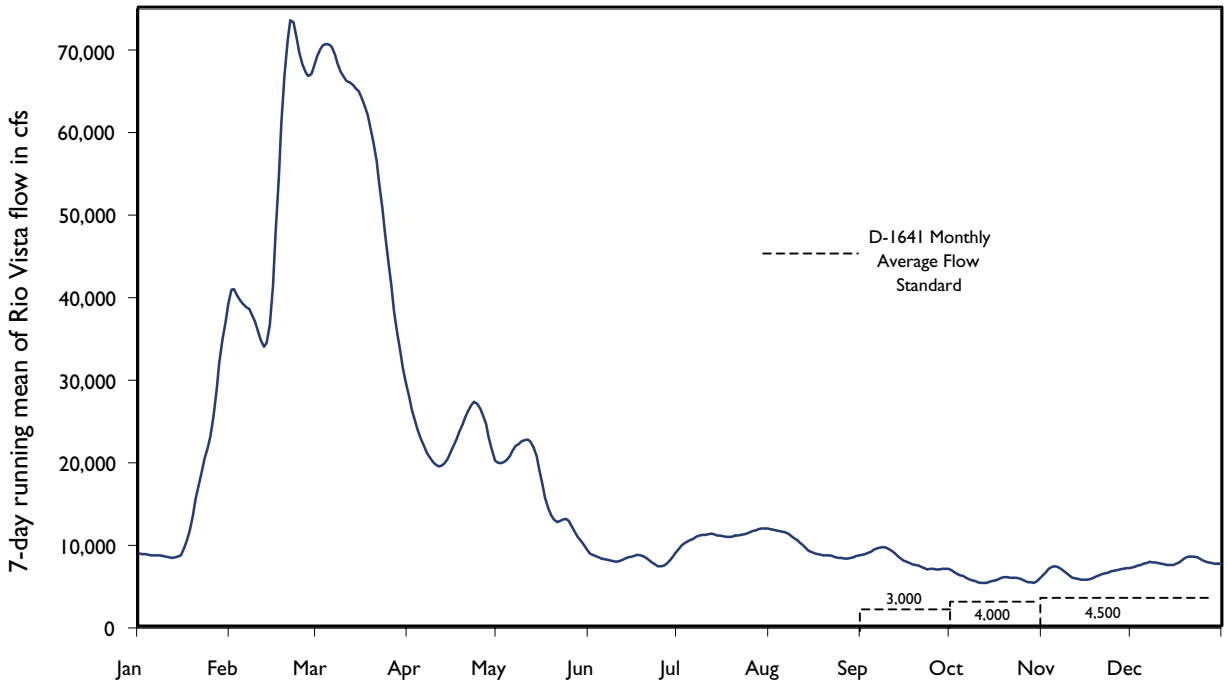


Figure 4-6. Sacramento River wet-year flow minimums at Rio Vista, 2000

D-1641 contains minimum monthly average NDOI standards for January and July-December. During January, the minimum monthly flow is set at 6,000 cfs when the previous month's Eight River Index (PMI) is greater than 800 taf; otherwise it drops to 4,500 cfs. The wet-year and above-normal minimum monthly NDOI objectives for July, August, September, and October are 8,000 cfs, 4,000 cfs, 3,000 cfs, and 4,000 cfs, respectively, and they rise to 4,500 cfs for November and December.

D-1641 also sets a habitat protection outflow from February through June, with a minimum daily NDOI of 7,100 cfs calculated as a 3-day running average. The objective may also be met by a daily average or 14-day running average EC of 2.64 mS/cm at Collinsville. Monthly NDOI habitat protection minimums for February through June are 7,100, 11,400, or 29,200 cfs depending upon whether X2 compliance is met at Collinsville, Chipps Island, or Port Chicago, respectively.

All NDOI standards were met during 2000 and the highest monthly average NDOI occurred in March with 103,865 cfs. The lowest monthly average occurred in September with 4,934 cfs (Table 4-8, Figure 4-7).

Delta Exports

The Sacramento-San Joaquin Delta provides the major source of water for SWP deliveries south of the Delta. Inflow from the Kern River Intertie and storm flows entering the California Aqueduct are also water sources for the SWP although there were no inflows from the Intertie or floodwater flows in 2000, as mentioned in Chapter 3.

Banks Pumping Plant has the capacity to export water at a rate of 10,670 cfs, although the Aqueduct capacity below Banks Pumping Plant physically limits exports to 10,300 cfs. In addition, a Corps permit (Public Notice 5820A) limits the diversion rate at Clifton Court Forebay to 6,680 cfs, except from December 15 to March 15, when exports may increase by one-third of the San Joaquin River flow when its flow exceeds 1,000 cfs. San Joaquin River flow at Vernalis was in excess of 1,000 cfs throughout 2000, allowing corresponding increases in the export rate. Export pumping rates are increased on

Table 4-8. D-1641 NDOI Flow Standards, 2000 (cfs)

Flow Standards	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
NDOI												
MM>	4,500[a]						8,000	4,000	3,000	4,000	4,500	4,500
Min. daily 3-dm		7,100	7,100[b]	7,100								
Min. daily 14-dm					4,000[c]	4,000[c]						
Actual Flows												
MM	19,937	97,797	103,865	28,643	23,417	9,898	9,821	6,526	4,934	5,777	5,701	6,953
Min 3-dm flow		30,352	29,354	18,499	12,544	7,089						

Note: Shaded areas = standard; MM = mean monthly; 3-dm = 3-day mean; 14-dm =14-day mean

[a]If PMI >800 taf, January standard rises to 6,000 cfs.

[b]March standard may be relaxed if PMI is <500 taf.

[c]If May estimate of Sacramento River Index is <8.1 maf, May and June MM objective is set at 4,000 cfs.

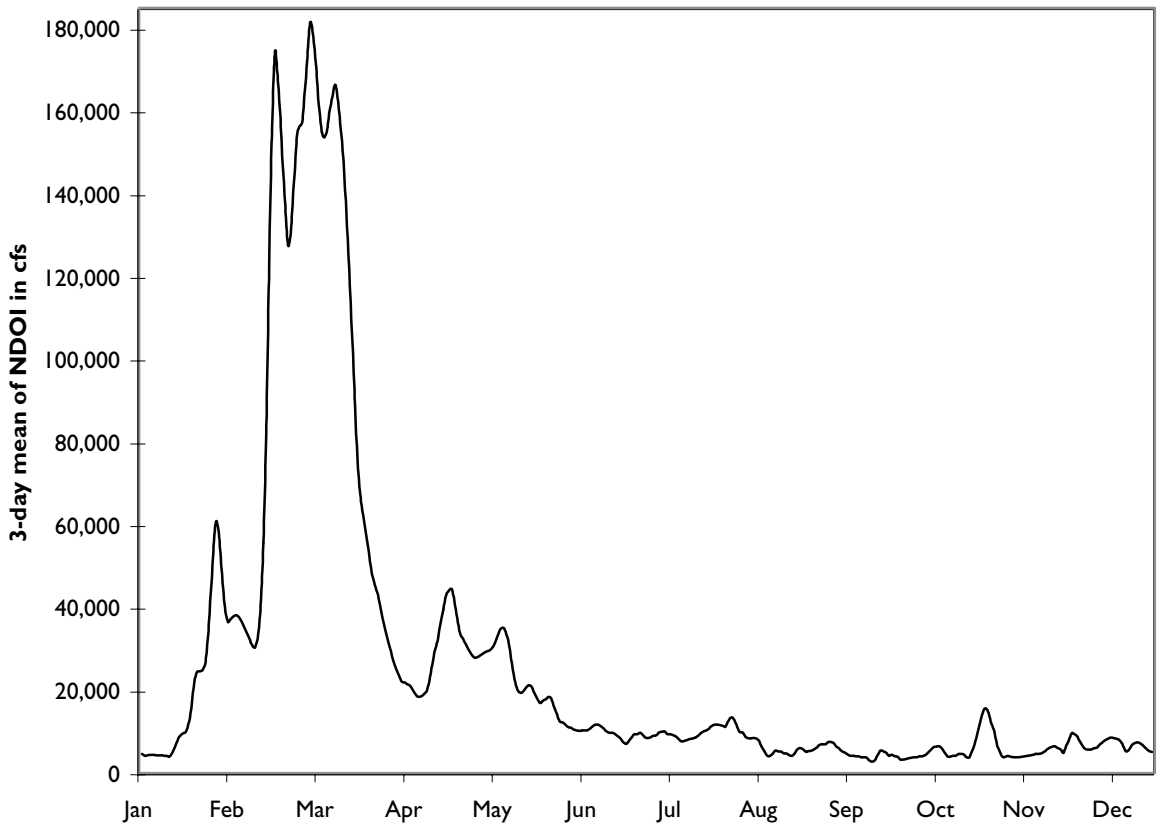


Figure 4-7. Net Delta Outflow Index, 2000

weekends to take advantage of less expensive off-peak electrical energy. This produces sharp peaks in the export rate at about 7-day intervals (Figure 4-8).

In 2000, the SWP diverted 3.74 maf at Banks Pumping Plant, about 138 percent of 1999 exports (2.71 maf), and 76 percent of all SWP deliveries, both SWP contractual and non-contractual (4.93 maf). Under the 1986 COA, SWP may export water for CVP later in the year to make up for exports not taken at its Tracy Pumping Plant under fisheries-related restrictions. D-1641 allows the SWP and CVP to use either project's pumping plants for exports to make up for export losses incurred for the protection of fisheries. These export exchanges may not jeopardize either project's deliveries and require permission from the CALFED Operations Group. Banks Pumping Plant pumped 104,727 af of water for the CVP during 2000 (Table 4-9).

Winter-run Chinook Salmon Export Restrictions. The long-term Winter-run Chinook Salmon Biological Opinion, released in 1993 and amended in March 1995, can restrict Delta exports based on the combined loss of winter-run-sized salmon smolt at the State and federal Delta export facilities, known as the *take level*. The Biological Opinion's incidental take statement invoked what is known as a *yellow light warning condition* when combined loss (Banks and Tracy) reached 2,897 smolts, equivalent to 1 percent of the 1999 estimated out-migrating juvenile winter-run salmon population. The Department and the Bureau voluntarily adjust pumping operations to reduce loss numbers when yellow light conditions are reached. Loss levels at 2 percent, or 5,794 smolts, trigger what is known as a *red light warning condition* and consultation with the Winter-run Chinook Salmon Monitoring Group is initiated. These yellow and red light export restrictions were in effect from October 1999 through May 2000, the

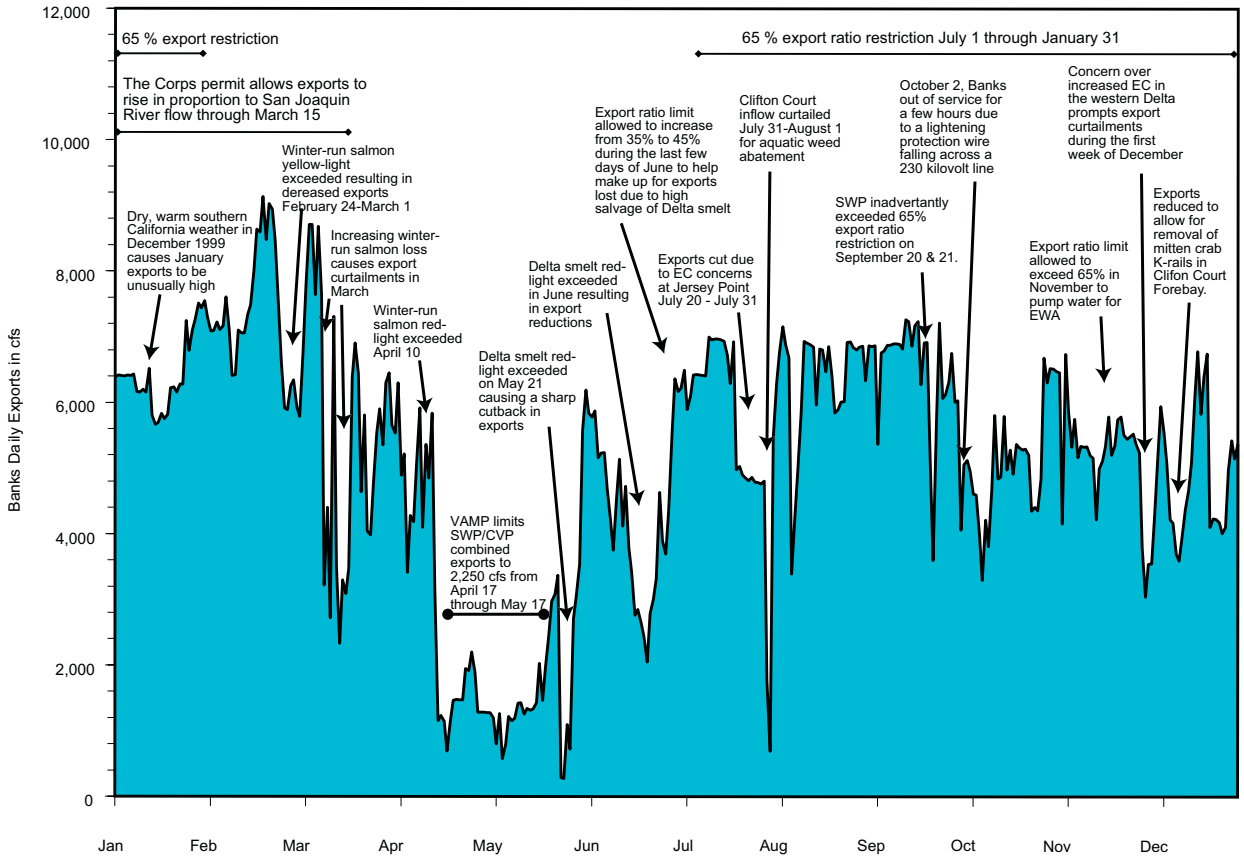


Figure 4-8. SWP Banks Pumping Plant exports during 2000, annotated with significant factors affecting export

Table 4-9. Delta Exports at Tracy and Banks Pumping Plants during 2000

Month	Export Rate SWP (cfs)	Banks Export For SWP (af)	Banks Export For CVP (af)	Total Banks Exports (af)	Total Tracy Exports (af)	SWP/CVP Combined Exports (af)
Jan	6,450	395,929	0	395,929	197,053	592,982
Feb	6,209	356,420	81	356,501	236,275	592,776
Mar	5,549	257,590	82,980	340,570	207,841	548,411
Apr	3,038	180,473	0	180,473	131,315	311,788
May	1,592	97,696	0	97,696	77,637	175,333
Jun	4,242	251,955	0	251,955	181,168	433,123
Jul	5,417	332,493	0	332,493	265,543	598,036
Aug	5,810	356,609	0	356,609	269,678	626,287
Sep	6,529	387,824	0	387,824	252,867	640,691
Oct	4,737	289,107	1,690	290,797	258,757	549,554
Nov	5,436	304,805	18,097	322,902	241,648	564,550
Dec	9,427	290,352	1,879	292,231	240,439	532,670
Total	--------	**3,501,253**	**104,727**	**3,605,980**	**2,560,221**	**6,166,201**

predominant period of salmon migration. The fish loss or estimated take is actually a calculated value derived from combined salvage numbers at SWP and CVP fish facilities expanded by empirically determined factors including sampling duration, salvage efficiency, forebay predation, and losses due to handling and hauling.

On February 18, 2000, the yellow light loss level was exceeded for winter-run-sized salmon and salvage for Delta smelt was quickly approaching the yellow light condition as well. As a result, NMFS and USFWS requested the Department and the Bureau to reduce pumping in an effort to avoid reaching the red light level for winter-run salmon and reduce the salvage of Delta smelt. Exports at Banks Pumping Plant were subsequently decreased from 9,000 cfs to 6,000 cfs from February 24 through March 1, 2000.

During March, Delta smelt salvage began a steady decline while winter-run-sized salmon loss continued to increase sharply. March exports at Banks Pumping Plant decreased to an average of 4,339 cfs but winter-run salmon loss continued to climb. The winter-run red light level of 5,794 fish was exceeded on April 10 and the Bureau sent a letter to inform NMFS of the occurrence on April 13, 2000. The letter outlined the project's conference call from April 12. It was noted that incidental loss of winter-run-sized Chinook salmon at the SWP and CVP export facilities had become very low in the last several weeks and that the projects would soon begin VAMP pumping reductions. The consensus of Data Assessment Team discussion was that no further actions were necessary at this time with respect to winter-run Chinook salmon.

The combined SWP/CVP seasonal winter-run–sized salmon loss for 2000 was 5,843 smolts (Figure 4-9).

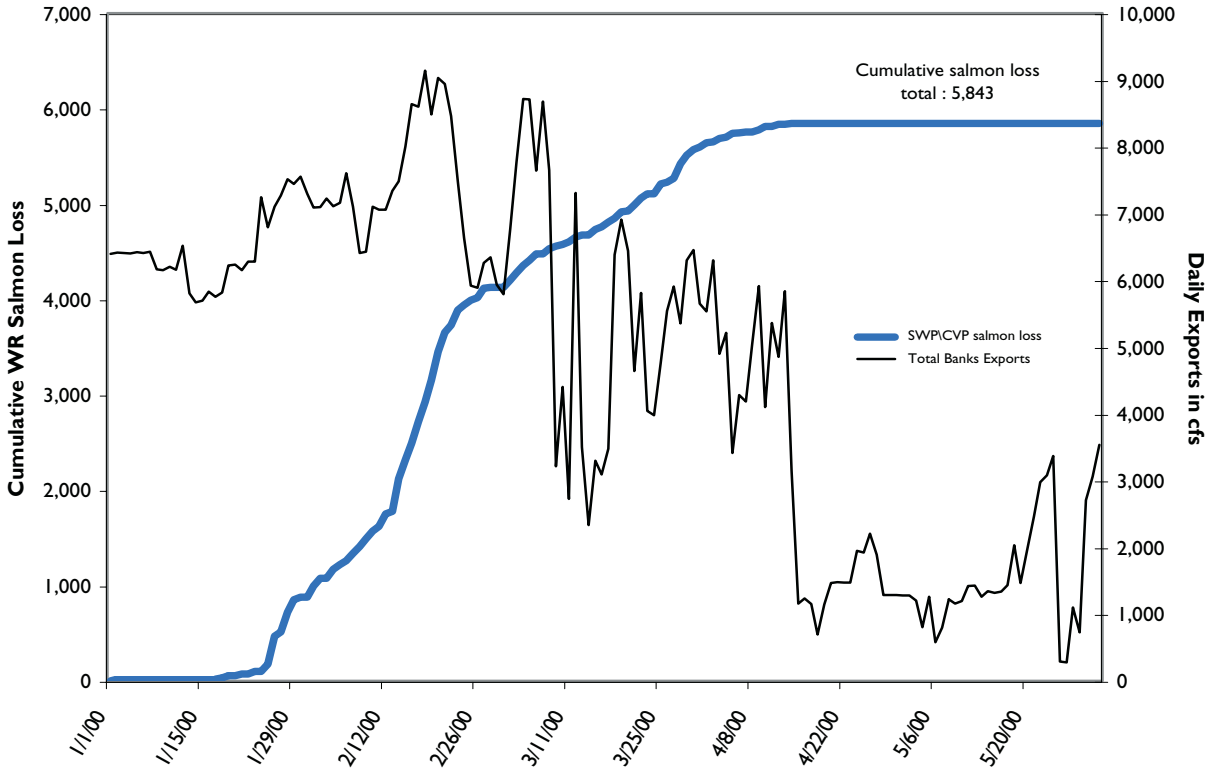


Figure 4-9. SWP/CVP cumulative winter-run salmon loss estimate and Banks total export, January 1, 2000, to May 31, 2001

Delta Smelt Export Restrictions. The amended Delta Smelt Biological Opinion established a year-round Delta smelt salvage action level of 400 fish (14-day running mean of daily salvage), known as the *yellow light level*, which triggers informal consultation with USFWS, the Bureau, DFG, and the Department. The combined salvage is the sum of Delta smelt salvaged at Banks and Tracy Pumping Plants expanded by other factors similar to those used in the winter-run salmon calculation. The *red light level* is the cumulative total of the combined salvage for each month and varies by water year type, with below-normal water years generally having a higher red light level than the level set for above-normal water years. Red light levels for above-normal water years are 2,378 for April and 9,769 for May and increase to 12,345 for April and 55,277 for May during below-normal water years.

Reaching the red light level triggers formal consultation with the fisheries agencies to determine whether additional actions are necessary to avoid jeopardizing the species.

Aerial view of Skinner Fish Facility, where an average of 15 million fish annually are diverted away from the eleven export pumps at Banks Pumping Plant.

As stated in the previous section on winter-run export restrictions, Delta smelt salvage spiked briefly in late February, but the 14-day running mean of salvage remained below the 400 fish yellow light level until late May.

During the VAMP period, which extended from April 17 to May 17, SWP exports remained relatively low, at approximately 1,500 cfs. Exports at Banks Pumping Plant were scheduled to increase following the VAMP period to about 5,500 cfs. However, actual SWP pumping during the last half of May was below 3,000 cfs due to concern over high salvage of Delta smelt. Despite export reductions, Delta smelt salvage rose dramatically in late May. On May 21, the red light level of 9,769 Delta smelt was exceeded and the Bureau and the Department reinitiated formal consultation with USFWS as a result. By the end of May, the cumulative total of combined Delta smelt salvage exceeded 49,000 fish.

SWP exports from the south Delta were constrained during June as the combined salvage remained high at the SWP and CVP facilities. The red light level was exceeded in June and salvage totaled 49,124 by the month's end. Salvage quickly declined in early July with total monthly salvage of 1,513 fish, below the yellow light level (Figure 4-10).

Sacramento Splittail Salvage. USFWS listed the Sacramento splittail as threatened under the federal Endangered Species Act on February 8, 1999. The listing, which became effective on March 10, had been considered since 1994. During 2000, a Federal District Court judge found that the decision by USFWS to list the splittail as endangered under FESA was not reached in accordance with the law. The judge remanded the decision to USFWS for further analysis and review. The Department and the Bureau have continued to meet with USFWS in an effort to establish an incidental take statement for operation of the SWP and CVP.

Though no formal take limits for splittail were in place during 2000, the fish salvage facilities of the SWP and CVP kept an accurate count of the combined splittail salvage. The combined salvage during 2000 is illustrated in Figure 4-11.

D-1641 Export Restrictions

Year-round Export Standards. D-1641 contains a year-round export standard, known as the *percent inflow diverted ratio,* that restricts exports by limiting them in proportion to Delta inflow. The percent inflow diverted standard is the sum of SWP and CVP south Delta exports divided by Delta inflow. The percent inflow diverted standard is calculated using a 3-day running average of exports and a 14-day running average of Delta inflow. During periods when CVP or SWP exports are dependent upon storage withdrawals from upstream reservoirs, the percent inflow diverted ratio is computed using 3-day running averages of both export rate and Delta inflow.

This percent inflow diverted ratio standard varies by month and is conditioned by the previous month's Eight River Index. The combined CVP/SWP export standard is typically set at 35 percent of Delta inflow from February through June and 65 percent during January and the remainder of the year.

During January 2000, when the diversion of as much as 65 percent of Delta inflow is allowed for the month, the percent inflow diverted average was about 43 percent. Water deliveries were unusually high during January due to warm, dry weather in Southern California during the previous month.

From February through June, the average percent of inflow diverted was 18 percent, well below the 35 percent standard. Exports were curtailed during February and March as a result of winter-run salmon loss and during May and

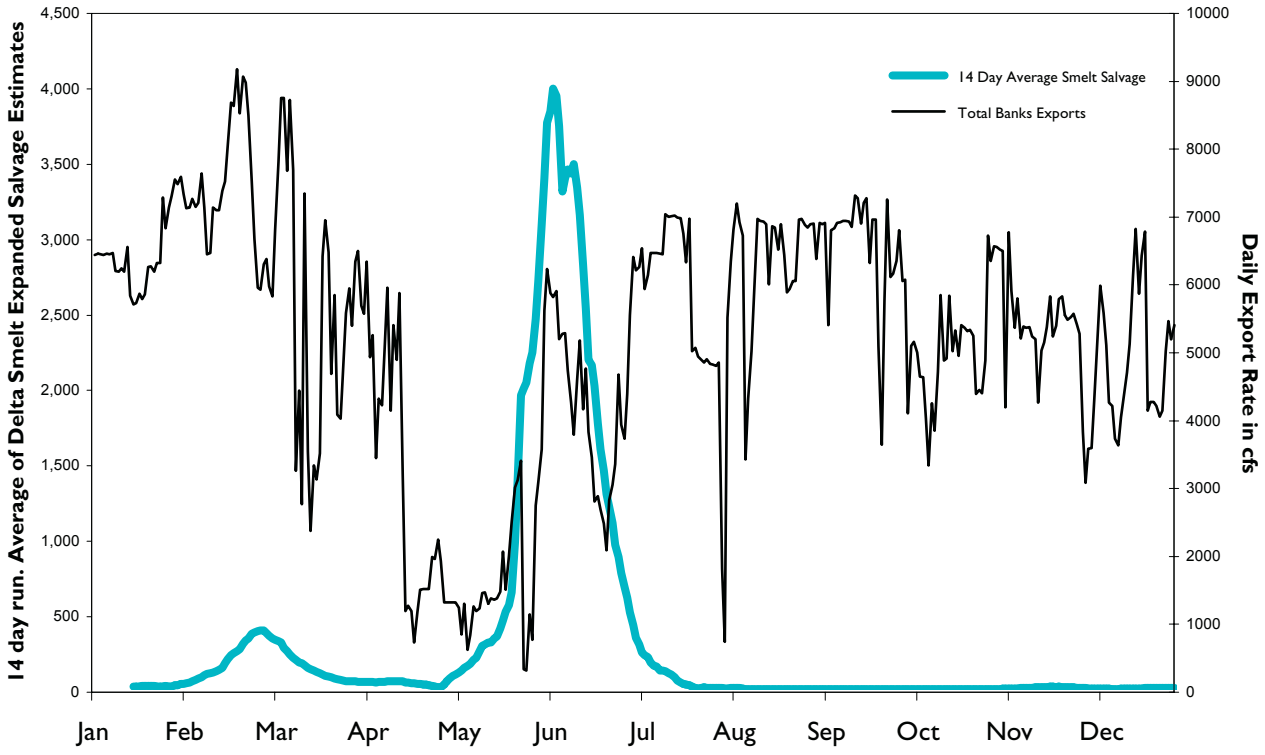


Figure 4-10. Expanded Delta smelt salvage estimates and Banks Pumping Plant exports, 2000

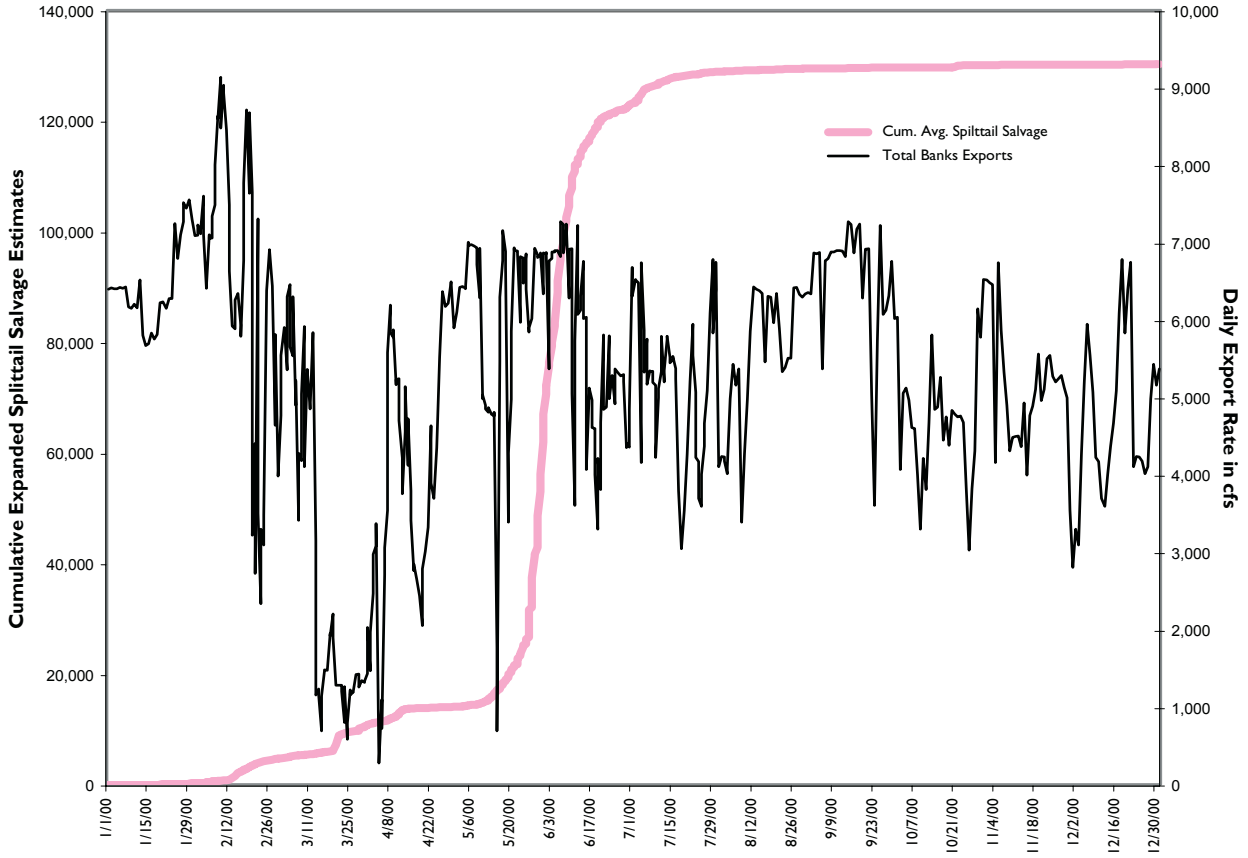


Figure 4-11. Expanded Sacramento splittail salvage estimates and Banks Pumping Plant exports, 2000

June due to high Delta smelt salvage. However, the percent inflow diverted ratio was relaxed during June 28-30 to 45 percent to help recover water supplies lost during spring export curtailments for protection of Delta smelt. From July through December, D-1641 allows combined exports to increase to 65 percent of Delta inflow — exports averaged 54 percent during this 6-month period. During July, the Department began a Clifton Court Forebay intake increase from 6,680 cfs to 7,180 cfs. This increase was approved for July through September for a period of 3 years by the Corps. SWP used the increased capacity in 2000 to help make up for export reductions taken earlier in the year for fisheries concerns. However, on July 20 intake at Clifton Court Forebay was decreased from the scheduled 7,180 cfs to 5,000 cfs for the balance of the month in an attempt to improve the 14-day running average of EC at Jersey Point. From July 31 to August 1, intake at Clifton Court Forebay and exports from Banks Pumping Plant were curtailed to accommodate spraying of aquatic weeds in the forebay.

On September 20 and 21, 2000, SWP and CVP inadvertently exceeded the 65 percent of inflow diverted standard. Letters of explanation were sent out to the Corps and SWRCB; in addition, copies were forwarded to the Operations and Fisheries Forum describing the occurrence and actions taken.

On October 2, Banks Pumping Plant was forced out of service for a short time when a lightening protection wire fell across all three phases of the Contra-Tesla 230 kilovolt line. Pacific Gas & Electric quickly made temporary repairs and Banks was operational with minimal delay. In late October, the Department and the Bureau notified SWRCB, with permission from the fisheries agencies, of their intent to exceed the 65 percent inflow diverted standard to pump water for the Environmental Water Account.

The percent diverted ratio was allowed to increase above the 65 percent standard to divert water for the Environmental Water Account (see EWA section) and EWA water was exported under the relaxed standard beginning in November.

At the beginning of December 2000, unusual tidal conditions brought about a sudden degradation in western Delta EC resulting in SWP and CVP south Delta export curtailments for several days during the first week of December. Removal of the mitten crab k-rails in the channel connecting Clifton Court Forebay with Banks Pumping Plant caused export reductions during the second week of December.

Spring Export Restrictions. D-1641 also contains an export limitation applied during the spring pulse flow period on the San Joaquin River, limiting combined exports from April 15 through May 15 to 1,500 cfs, or 100 percent of the 3-day average of the San Joaquin River flow at Vernalis, whichever is greater. The San Joaquin River Agreement, completed in April 1998, includes VAMP, which contains SWRCB-approved alternate flow and export targets that may be used in lieu of the D-1641 criteria for the protection of San Joaquin River salmon. In 2000, the VAMP season extended from April 17 to May 17, during which SWP and CVP used 2,250 cfs as the combined export target. Actual exports nearly mimicked this target (2,249 cfs), which was about 10 percent of Delta inflow during this period.

All D-1641, ESA-related, and VAMP export criteria were met during 2000 (Figures 4-11 and 4-12, Tables 4-9 and 4-10).

Environmental Water Account. EWA is a cooperative water management program made up of five State and federal agencies. EWA was mandated in the CALFED Record of Decision signed on August 28, 2000. EWA was designed to help protect endangered and/or threatened fish species of the Bay-Delta estuary through environmentally beneficial changes in the operations of SWP and CVP, at no uncompensated water cost to the SWP/CVP water users. Water year 2001 was the first year of operation for EWA, which began in October 2000.

Real-time Monitoring Program. The 1994 Principles of Agreement endorsed the use of

Clifton Court Forebay with Skinner Fish Facility in the foreground

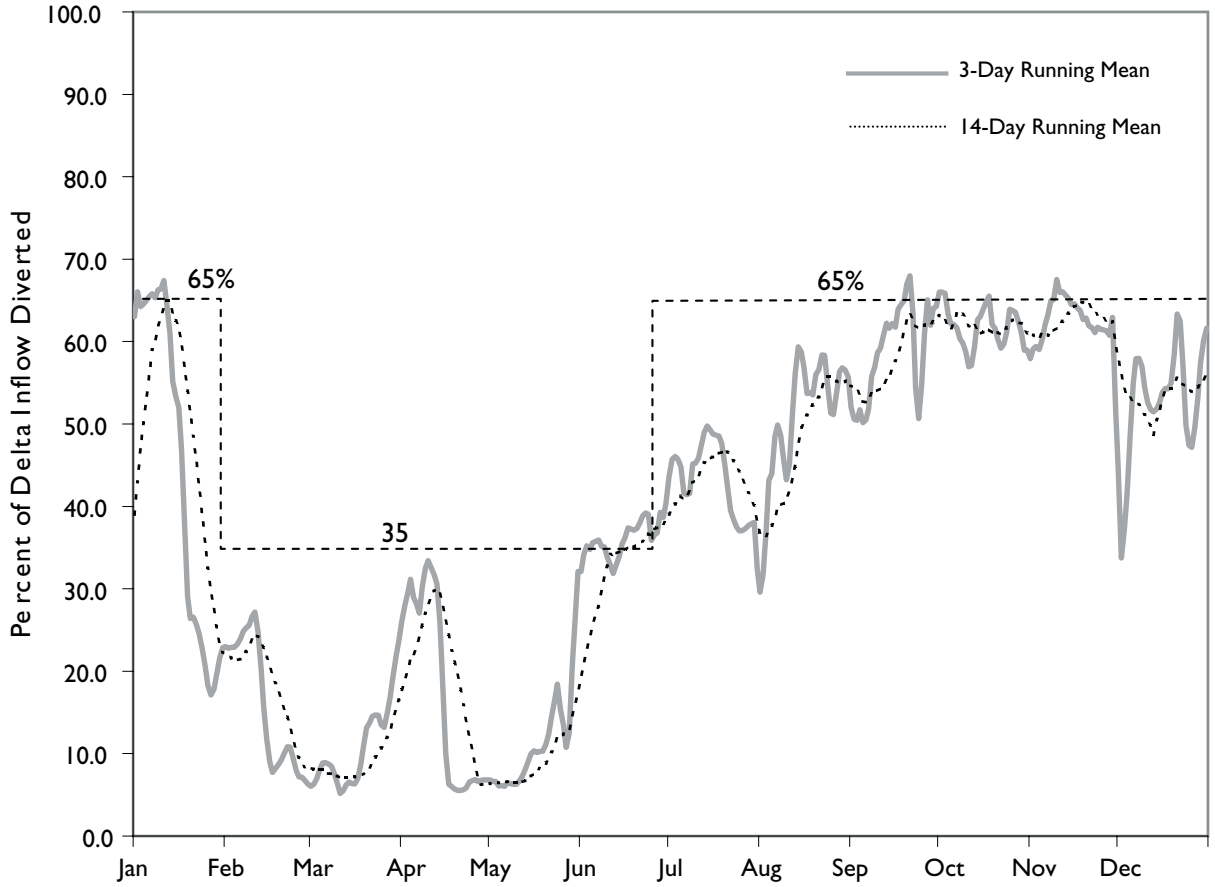


Figure 4-12. Combined Delta exports as percent of inflow diverted and D-1641 standards, 2000

real-time fisheries monitoring to enhance operational flexibility through the adjustment of export limits while insuring biological protection consistent with federal and State ESA. The 2000 Real-time Monitoring Program, which began on April 3 and ended July 31, 2000, provided water project operators with field information and monitoring data within 36 hours, timely enough to protect targeted fish species from entrainment at the Delta export facilities while providing for water supply reliability. Thirty-seven Delta sites were sampled 5 days per week and the CALFED Operations Group evaluated the field results to determine any need for operational change. Monitoring efforts specifically targeted winter-run salmon, Delta smelt, and Sacramento splittail.

North Bay Aqueduct Operations

The North Bay Aqueduct system begins in the north Delta at the Barker Slough Facilities near Rio Vista. Sacramento River and local watershed water passes through Cache, Lindsey, and Barker Sloughs to reach the Barker Slough Pumping Plant. From the Barker Slough Pumping Plant, water is conveyed by pipeline for 24 miles northwest to the Cordelia Pumping Plant. Deliveries are made to Solano County water users via turnouts along the pipeline and to Napa County users from the Cordelia Pumping Plant. NBA extends approximately 6 miles beyond the Cordelia Pumping Plant to the Napa Terminal Tank. This aqueduct will ultimately supply 25 taf annually to Napa and 42 taf to Solano. Deliveries to NBA totaled 41,973 af during 2000, about 1 percent of total SWP deliveries.

Table 4-10. D-1641 Export Limits Based on Percentage of Delta Inflow Diverted, 2000

Month	Maximum % Inflow allowed as combined export (%)	Mean % inflow diverted	
		3-day running mean[a]	*14-day running mean*[a]
Jan	65	42.5	49.2
Feb		15.9	18.3
Mar		10.8	9.1
Apr[b]	35	17.7	19.7
May[b]		11.3	9.0
Jun[c]		36.1	32.6
Jul		43.1	43.3
Aug		50.8	47.6
Sep	65	59.0	57.9
Oct		62.0	62.0
Nov[d]		62.3	62.5
Dec		52.9	54.0

Note: Combined export is defined as Clifton Court Forebay inflow (minus BBID diversions from Clifton Court) plus Tracy Pumping Plant exports.

[a]Percent of Delta inflow diverted is calculated using the export rate as a 3-day running mean and the Delta inflow as a 14-day running mean, except when the SWP or CVP are making storage withdrawals for export. In this case, both the export rate and Delta inflow are 3-day running means.

[b]VAMP provides alternative spring pulse flow and export criteria that is recognized by SWRCB and is used in lieu of D-1641 criteria.

[c]The percent of inflow diverted limit was increased from 35 percent to 45 percent during the last few days of June to help make up for exports lost during spring export restrictions related to high salvage of Delta smelt.

[d]The 65 percent of inflow diverted limit was allowed to be exceeded during November to pump water for EWA.

In 2000, NBA conveyed 33,773 af Table A water supply — 30,637 af (91 percent) to Solano and 3,136 af (9 percent) to Napa. Napa and Solano also received 1,337 af of water under Article 21 and Solano received 3,921 af of non-SWP water.

Barker Slough Pumping Plant has a maximum pumping capacity of 160 cfs and is screened to exclude juvenile salmon from entrainment; however, the screens are not able to exclude the smaller Delta smelt. The amended Delta smelt opinion requires a reduction of diversions from Barker Slough to a 5-day running average of 65 cfs when Delta smelt under 20 millimeters are detected at three sites upstream of the plant. The running averages are calculated into a weighted average, with the weight of each station dependent upon the proximity to the Barker Slough pump intake. The opinion also set an estimated numerical loss limit at the pumping plant during Delta smelt spawning season.

From February 15 to July 14, 2000, no export reductions due to the presence of Delta smelt were required either because the Department did not receive viable data reporting that the Delta smelt catch at the three Barker Slough stations had risen to the level described in the amended Delta Smelt Biological Opinion to establish Delta smelt presence or, when viable data indicating the presence of Delta smelt was received, exports were already below the 5-day running average of 65 cfs.

Delta Water Management

South Delta Improvements Program

During the latter half of the 1990s, the Department sought to step up the construction of south Delta facilities to improve Delta water conditions. This was accomplished through the Interim South Delta Program. In 1999, the CALFED Bay-Delta Program decided to include south Delta facilities as a key component of the CALFED decision-making process. ISDP was subsequently renamed the *South Delta Improvements Program* and its purpose was revised to focus on the following issues:

(1) improve the reliability of existing SWP facilities;
(2) ensure that water of adequate quantity and quality is available for diversion to the South Delta Water Agency service area for beneficial use; and
(3) reduce the effects of SWP exports on both aquatic resources and direct losses of fish in the south Delta.

A preferred plan is being developed for SDIP as part of the ongoing process of preparing project-specific environmental documentation. Planning activities for increasing Banks Pumping Plant to the 10,300 cfs export maximum continued during 2000. The proposed project includes the construction of a new screened intake to Clifton Court Forebay and four permanent, operable flow control facilities in south Delta channels. These improvements are key components of the CALFED Conveyance Program and they would improve SWP water supply reliability and increase operational flexibility. In addition, the construction of flow control structures in south Delta channels would allow the Department and the Bureau to improve conditions for local agricultural diverters in the vicinity of SWP and CVP south Delta export facilities.

South Delta Temporary Barriers Project

The Department has constructed seasonal barriers under the program's South Delta Temporary Barriers Project since 1990 to improve south Delta water conditions and collect data for the design and operation of proposed permanent barriers. The temporary barriers have been placed across Middle River, Old River at Tracy, Grant Line Canal, and Old River at Head (see Figure 4-12).

The Old River at Head barrier prevents San Joaquin River flow from entering Old River and flowing toward SWP and CVP export facilities. The additional flow in the San Joaquin River is intended to guide juvenile salmon to the ocean in the spring and improves San Joaquin River dissolved oxygen levels for salmon migrating upstream in the fall to spawn.

The Department is obligated under the San Joaquin River Agreement, which facilitates the implementation of VAMP, to install and operate the Old River at Head fish barrier in a manner that will protect San Joaquin River Chinook salmon smolts and in conjunction with the flows provided during the pulse flow period. In spring 2000, the Old River at Head barrier was operational by April 16 and was removed by June 2. In the fall, the Old River at Head barrier was operational by October 7 and removal was completed on December 8, 2000.

The Middle River barrier is a temporary rock barrier installed near Victoria Canal, located about one-half mile south of the confluence of Middle River and Trapper Slough. This tidally-controlled barrier improves water circulation and water levels during the agricultural irrigation season. In 2000, the Middle River barrier was installed on April 6 and removal was completed on October 7.

The Old River barrier at Tracy has been installed annually in spring since 1991. The barrier is installed on Old River, one-half mile east of Tracy Pumping Plant. The Old River barrier at Tracy provides similar benefits to those of the Middle River barrier. The Old River at Tracy barrier was installed on April 6 and its removal completed on October 7, 2000.

The Department began installing the Grant Line Canal barrier east of Tracy Boulevard Bridge in 1996. This barrier provides benefits similar to those of the Middle River barrier. In 2000, this barrier was installed on June 1 and removed October 7 (Table 4-11).

Table 4-11. Dates of Installation and Removal of Temporary South Delta Barriers, 2000

Barriers	Installation Dates Completed	Removal Dates Completed
Middle River	April 6	October 7
Old River near Tracy	April 6	October 7
Old River at Head		
Spring barrier	April 16	June 2
Fall barrier	October 7	December 8
Grant Line Canal barrier	June 1	October 7

5. Delta Water Quality Standards

Sacramento-San Joaquin Delta water quality is influenced by the quality and quantity of tributary inflows, regulated discharges, and agricultural drainage, including drainage from Delta islands, seawater intrusion into the Delta's western channels, and by operations of the SWP and CVP. The SWP and CVP are required, under their SWRCB water right permits, to meet the water quality standards in SWRCB's D-1641, which was designed to protect the beneficial uses of Delta water.

Water quality standards and objectives are categorized by the beneficial uses they are intended to protect under broad categories that include municipal and industrial, agricultural, and fish and wildlife. The water quality compliance stations, including Suisun Marsh sites, are shown in Figure 5-1. The Department utilizes the following measures to meet D-1641 water quality and flow standards: (1) releases from upstream reservoirs; (2) operation of the Delta Cross Channel Gates; (3) Delta pumping operations; and (4) the construction of temporary rock barriers (see Chapter 4).

D-1641 incorporates the D-1422 San Joaquin River salinity standard at Vernalis, and a multi-location San Joaquin River dissolved oxygen objective is contained within the 1995 Bay-Delta Water Quality Control Plan. The Plan also introduced a narrative objective for salmon protection and for the protection of brackish tidal marshes of Suisun Bay. Operational standards are summarized in Table 5-1.

Municipal and Industrial Standards

Municipal and industrial water quality standards based on mean daily chloride values are set at several Delta export locations: Clifton Court Forebay, Tracy Pumping Plant, Contra Costa Canal at Pumping Plant #1, Barker Slough, and Cache Slough. The Clifton Court Forebay is the start of the SWP's California Aqueduct and Tracy Pumping Plant is the start of CVP's Delta-Mendota Canal. The Contra Costa Canal Intake at Rock Slough is at the start of a supply canal that conveys water to eastern Contra Costa County. Cache Slough is an intake for the City of Vallejo. The Cache Slough standard was not in effect in 2000 because water has not been withdrawn from the site in several years. A mean daily chloride standard of not more than 250 mg/L was in effect for the entire 2000 calendar year at all the other export locations and was met at all stations (Figure 5-2).

D-1641 contains an additional municipal and industrial standard requiring that chloride not exceed 150 mg/L for a specified number of days accrued in intervals of at least 2 weeks, at the better of two stations, either the Contra Costa Canal Pumping Plant #1 or the Antioch Water Works Intake. The percentage of days in the calendar year required by this standard is a function of water year type. It varies between 42 and 66 percent of the year, becoming less stringent under drier conditions. The wet-year 240-day (66 percent of the year) criterion was met at the Contra Costa Canal Pumping Plant #1 on September 11, 2000.

Table 5-1. D-1641 Wet Year Water Quality Standards for the Sacramento-San Joaquin Delta during 2000

Compliance Location	Standard	
	Municipal and Industrial	
Contra Costa Canal Intake, Clifton Court Forebay, Tracy Pumping Plant, Contra Costa Canal Intake, Barker Slough Pumping Plant, and Cache Slough Vallejo Intake	md CL <250	All months
Contra Costa Canal Intake or Antioch Water Intake	daily CL <150	240 days in the year
	Agricultural	
Western and Interior Delta		
Emmaton, Jersey Point, Terminous, and San Andreas Landing	14 dm EC <0.45	April 1-August 15
Southern Delta		
San Joaquin River at Vernalis	30 dm EC <0.7 30 dm EC <1.0	April-August September-March
San Joaquin River at Brandt Bridge, Old River near Middle River, and Old River at Tracy Road Bridges	30 dm EC <1.0	all months
Export Area		
Clifton Court Forebay and Tracy Pumping Plant	mm EC <1.0	all months
	Fish and Wildlife	
Dissolved Oxygen[a]		
San Joaquin River between Turner Cut and Stockton	DO >6.0	September-November
San Joaquin River Salinity		
Jersey Point to Prisoner's Point	14 dm EC <0.44	April-May
Habitat Protection Salinity Starting Condition February starting salinity: - If January 8-River Index >900 taf, then the daily or 14-day running average EC at Collinsville ≤2.64 mS/cm for at least 1 day between February 1-14. - If January 8-River Index is between 650 TAF and 900 TAF, then the CALFED Operations Group will determine if this requirement must be met. See Table 5-3 for determination of compliance of 2.64 mS/cm at Chipps Island or Port Chicago. *Suisun Marsh (see Table 5-4)*		

Note: DO: dissolved oxygen (mg/L); CL: chlorides (mg/L); EC: electrical conductivity (mS/cm); md: mean daily; 30 dm: 30-day running mean; 14 dm: 14-day running mean; mm: mean monthly; 28 dm: 28-day running mean.

[a]Dissolved oxygen objective is contained in SWRCB's 1995 Bay-Delta Plan.

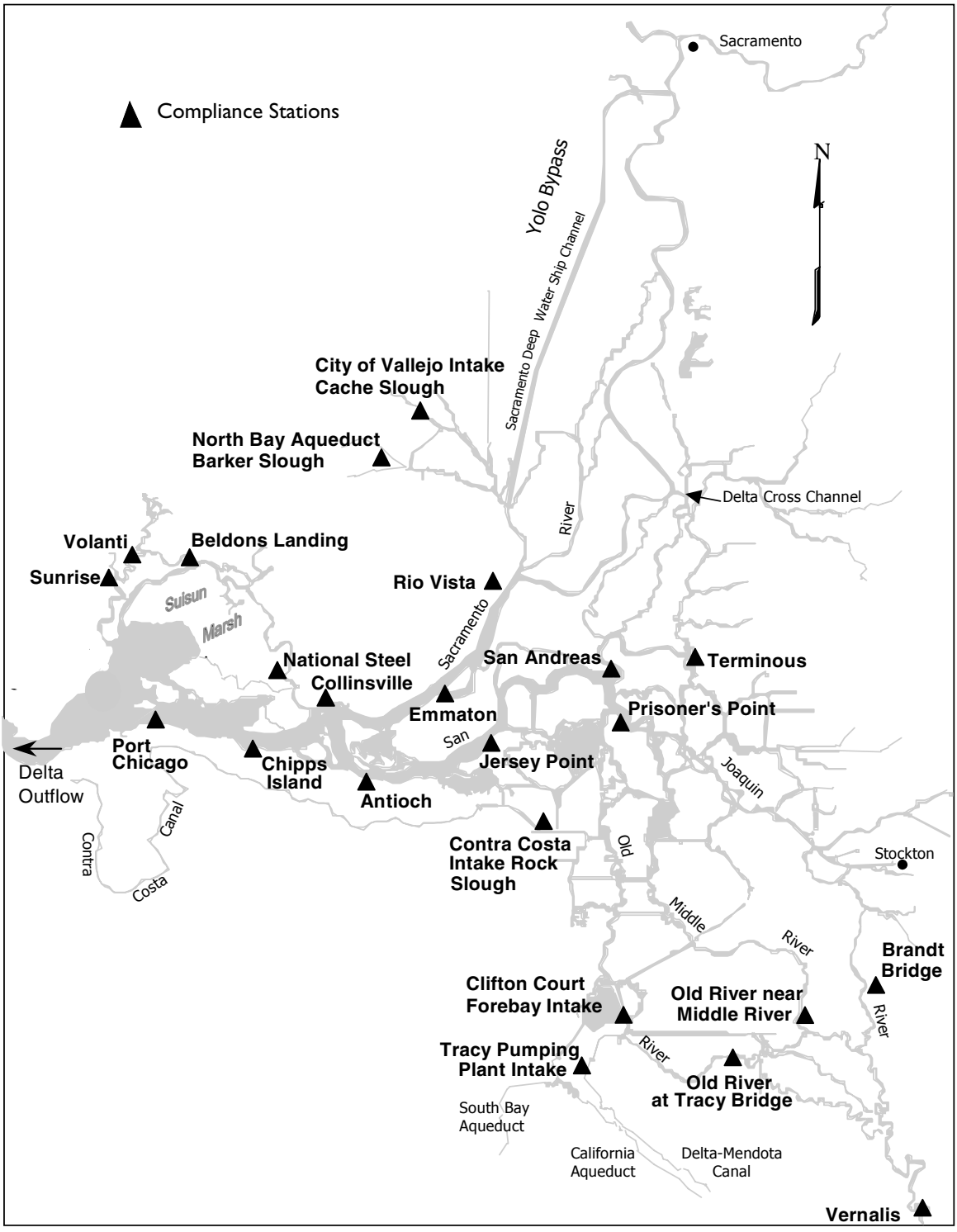


Figure 5-1. D-1641 water quality compliance locations in the Sacramento-San Joaquin Delta

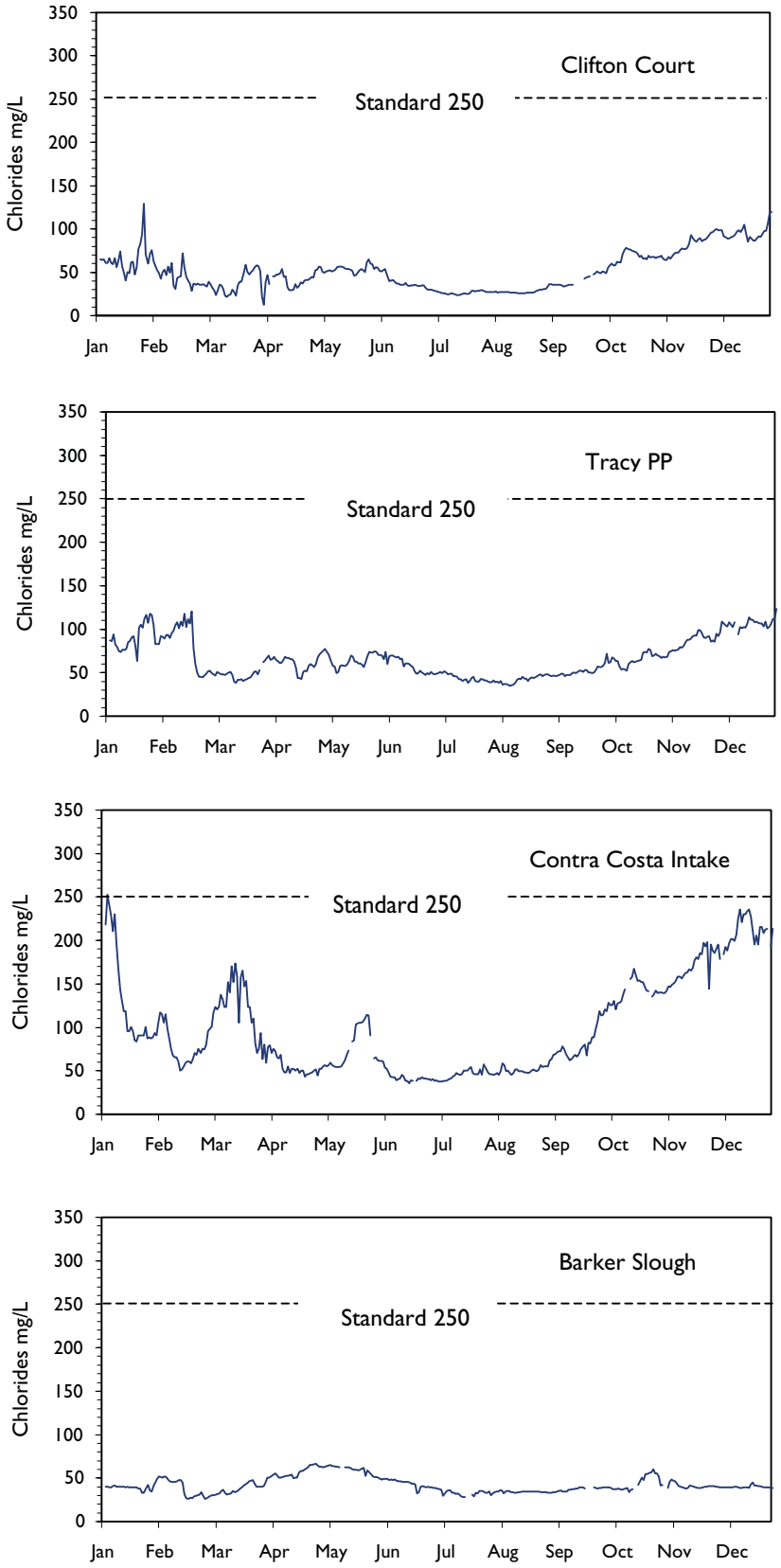


Figure 5-2. Municipal and industrial water quality standards, 2000

Agricultural Standards

Agricultural EC standards are contained within D-1641 to protect Delta agriculture during the irrigation season, from April 1 to August 15. Compliance locations in the western Delta include Emmaton and Jersey Point, with San Andreas Landing and Terminous in the interior Delta. Additional year-round compliance locations in the southern Delta are at Vernalis and Brandt Bridge; during September and October they are near the export areas at Clifton Court Forebay and Tracy Pumping Plant. When hydrologic conditions are drier than average, the standards are relaxed during the latter part of the irrigation season to reflect the water quality that would have occurred in the absence of the SWP and CVP. Under critical-year conditions, relaxation occurs for the entire growing season to reflect salinity intrusions expected with lower basin runoff into the Delta. The wet year agricultural water quality standard is set as a maximum 14-day running average EC of 0.45 mS/cm at Emmaton, Jersey Point, Terminous, and San Andreas Landing. The Vernalis agricultural standard, based on a 30-day running average, is set at 0.70 mS/cm from April-August and rises to 1.0 mS/cm September-March. The year-round export area standard (maximum monthly average) is also 1.0 mS/cm (Figures 5-3, 5-4, and 5-5).

The Sacramento-San Joaquin Delta is an important wintering habitat for millions of ducks and geese traveling on the Pacific flyway.

The responsibility for meeting standards and objectives is generally apportioned under COA to be met by the Department and the Bureau, with the exception of SWRCB San Joaquin River agricultural standards at Vernalis and Brandt Bridge. These agricultural standards are the expressed responsibility of the Bureau, since the Department does not regulate any reservoirs upstream of the San Joaquin River. During 2000, the Department met all standards for which it has responsibility under COA and SWRCB. These included the Emmaton, Jersey Point, Terminous, and San Andreas Landing agricultural standards. The Department also has an obligation to maintain water quality for agricultural uses under the 1981 North Delta Water Agency contract, as amended.

Fish and Wildlife Standards

D-1641 contains several water quality standards for the protection of Delta fish and wildlife. These include a water quality standard for EC on the San Joaquin River measured between Jersey Point and Prisoner's Point and at several locations in the Suisun Marsh. Suisun Marsh standards are discussed below in the Suisun Marsh Protection Plan and Preservation Agreement section. Other objectives combining both EC and flow were set to protect the estuarine habitat in the Suisun Bay area. The San Joaquin River dissolved oxygen objective was carried over from D-1422 to the 1995 Bay-Delta Plan. All of these measures were established in part to encourage spawning and survival of striped bass and to protect migrating salmon.

San Joaquin River Salinity Standard

The Jersey Point and Prisoner's Point standard is set as a maximum 14-day running mean of 0.44 mS/cm during April and May to protect

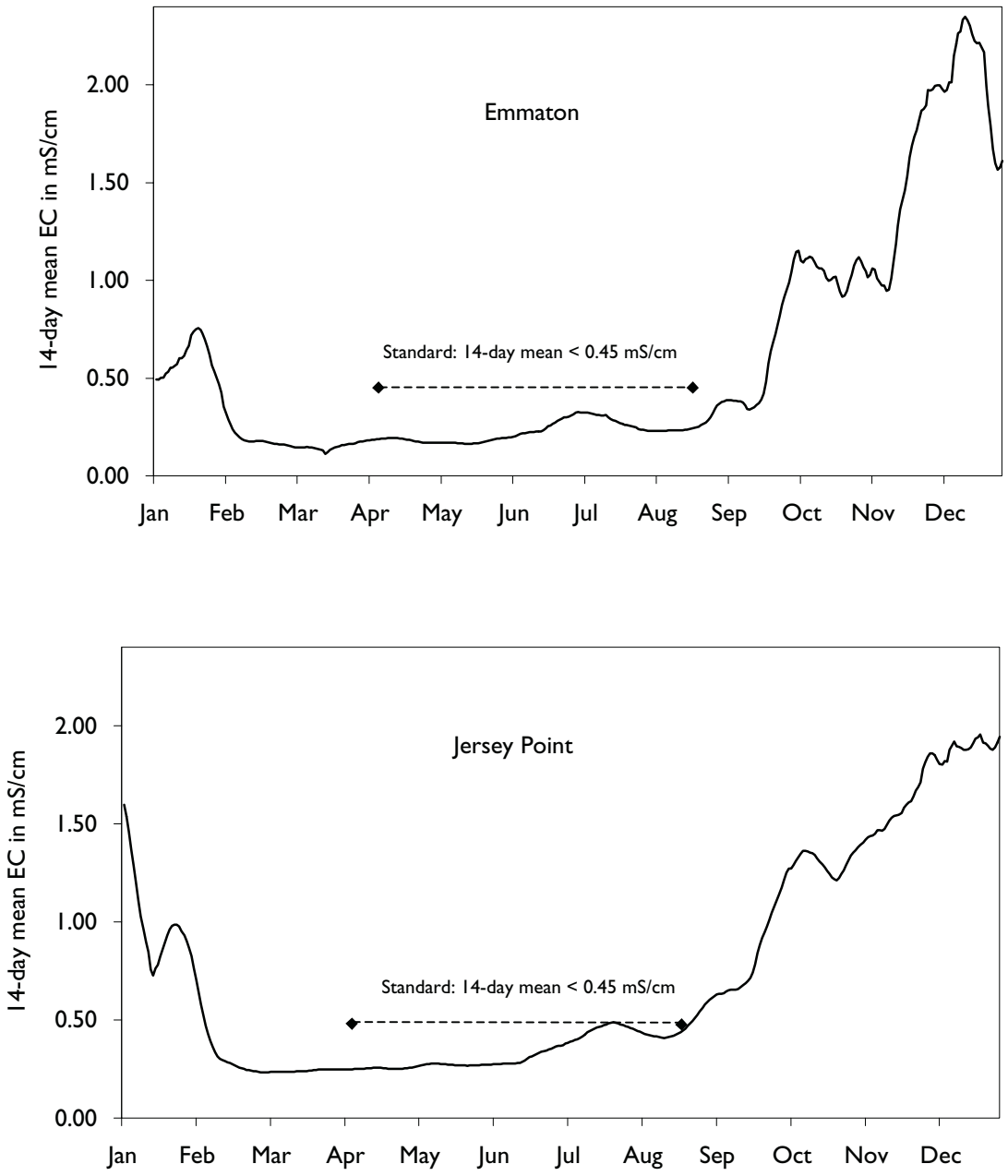


Figure 5-3. Agricultural water quality standards in the western Delta, 2000

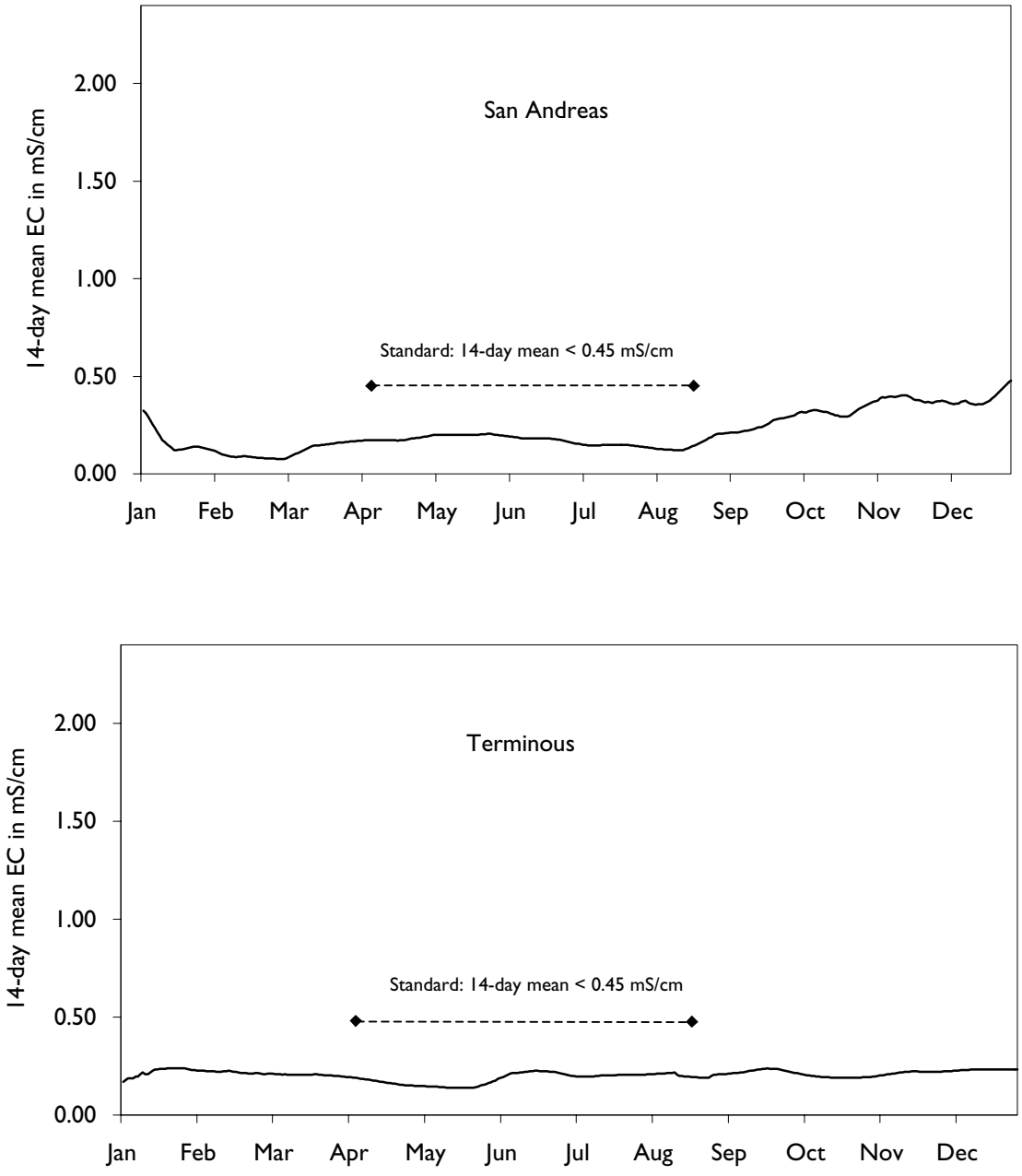


Figure 5-4. Agricultural water quality standards in the interior Delta, 2000

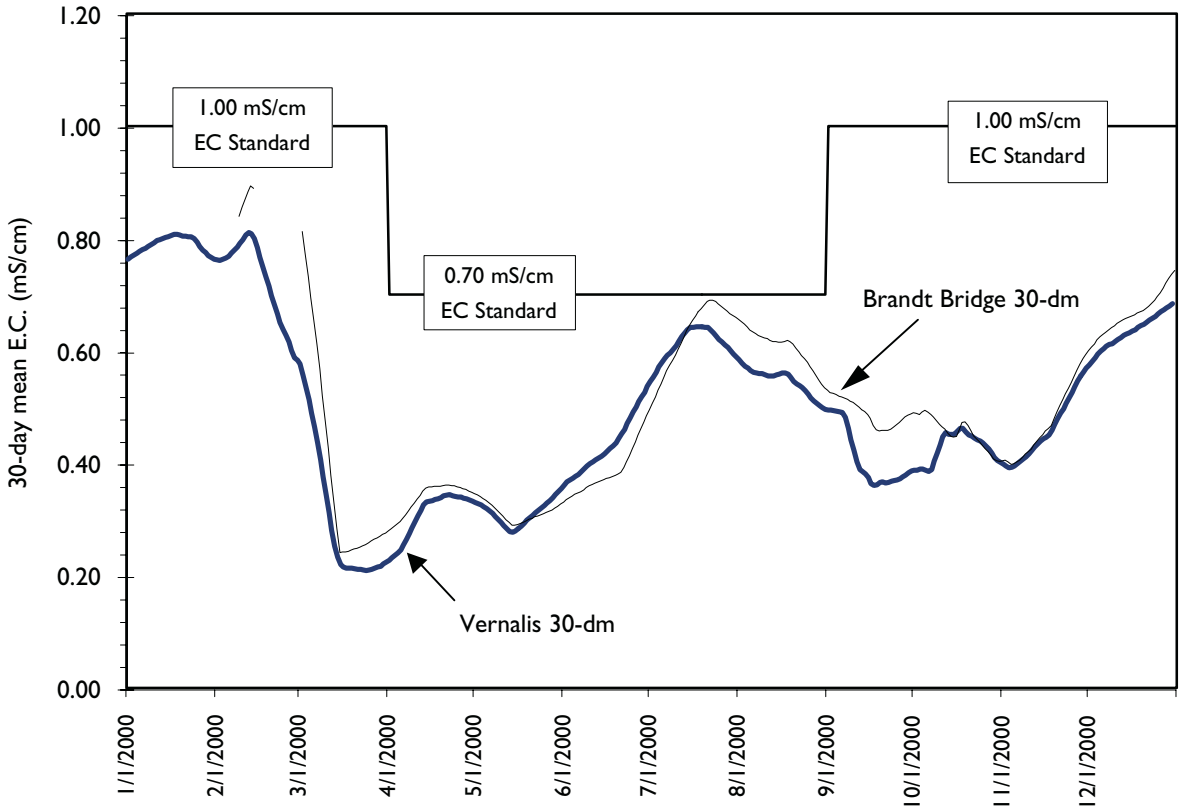


Figure 5-5. San Joaquin River EC standards, 2000. Data breaks during January and February resulted in data plots of less than 30-day means during January through March.

striped bass spawning habitat. Compliance with the Prisoner's Point EC standard is actually measured at San Andreas Landing, which provides a conservative estimate due to its location west of Prisoner's Point. Jersey Point values averaged 0.27 mS/cm and never exceeded 0.43 mS/cm during the April 1 through August 15 compliance period. During this compliance period, EC at San Andreas Landing averaged 0.16 mS/cm and never exceeded 0.19 mS/cm.

Dissolved Oxygen Objective

The Bay-Delta Plan includes a dissolved oxygen objective to protect fall-run salmon migration in the lower San Joaquin River similar to, but more stringent than, the DO standard in D-1422. DO levels are required to be at least 6.0 mg/L during September through November. During late summer and early fall each year, DO concentrations in the Stockton Ship Channel are closely monitored because they can deteriorate to critically low levels (<5.0 mg/L). DO is measured at 14 sites, at the water surface and at the channel bottom, between Prisoner's Point and the Stockton Deep Water Channel Turning Basin.

Low oxygen conditions may result from many factors — low stream inflows, intermittent reverse-flow conditions in the San Joaquin River past Stockton, warm water temperatures, reduced tidal mixing, and high biochemical oxygen demand levels as the result of regulated discharges in the Stockton area and recreational activity adjacent to the basin. The Department's Operation Control Office monitors DO in the Stockton Ship Channel as the basis for some operational decisions. The fall installation of the Old River at Head barrier is a commonly used remedy for low DO conditions in the lower San Joaquin River. The barrier increases net flows down the San Joaquin River past Stockton,

One of three 30-ton bridge cranes at the Port of Stockton

helping to improve dissolved oxygen levels, particularly in the eastern channel.

The fall Old River at Head barrier was installed on October 7, 2000, in response to relatively low San Joaquin River flows at Vernalis and projected fall flows which would be insufficient to alleviate low DO conditions in the eastern channel. Average daily flows in the San Joaquin River past Stockton ranged from -401 cfs to +626 cfs during August through October 2000.

DO in the western portion of the channel from Prisoner's Point to Disappointment Slough remained relatively high and stable throughout the study period, ranging from 6.7 to 11.2 mg/L. This is typical of most years in the western channel where tidal mixing and the lack of conditions favorable to the creation of high biochemical oxygen demand allow DO to stay at relatively high levels.

Though DO levels below 5.0 mg/L were rare during the 2000 study period, they did occur in the central portion of the channel on August 14 when water temperatures were highest and San Joaquin River flows were at their lowest. The minimum DO level measured at the bottom of the channel immediately east of Turner Cut was 4.5 mg/L. By August 29, DO had improved but a surface and bottom DO depression (an area with less than 6.0 mg/L) persisted in the central channel. DO levels improved in early September, but returned to depressed levels by the end of the month. Water temperatures (21 to 24° C) in the channel during September were slightly cooler than August and San Joaquin flows were similar.

DO levels sustained a gradual improvement during October due to cooler water temperatures (14 to 19° C) and locally improved flow conditions. Flows on the San Joaquin River past Vernalis ranged from 2,223 cfs to 3,658 cfs per day during October, and intermittent reverse flow conditions past Stockton were nonexistent throughout much of the month (Figure 5-6).

Monitoring on November 14 showed a sustained improvement in the DO levels throughout the channel, and no further studies were conducted. The Old River at Head barrier was removed on December 8, 2000.

Estuarine Habitat Protection Standard (X2)

D-1641 includes an estuarine habitat protection standard that incorporates a modified X2 criteria (geographic isohaline), first established in the 1994 Delta Smelt Biological Opinion. Delta outflow is used to maintain the position of 2-ppt isohaline (2 parts per thousand of salt in the water), measured as 2.64 mS/cm on the water's surface at either Chipps Island or Port Chicago during February through June. This required location of the isohaline is associated with fish and biota abundance.

The number of days per month when the daily averaged EC maximum (2.64 mS/cm) is in effect at Chipps Island or, under specific conditions, at

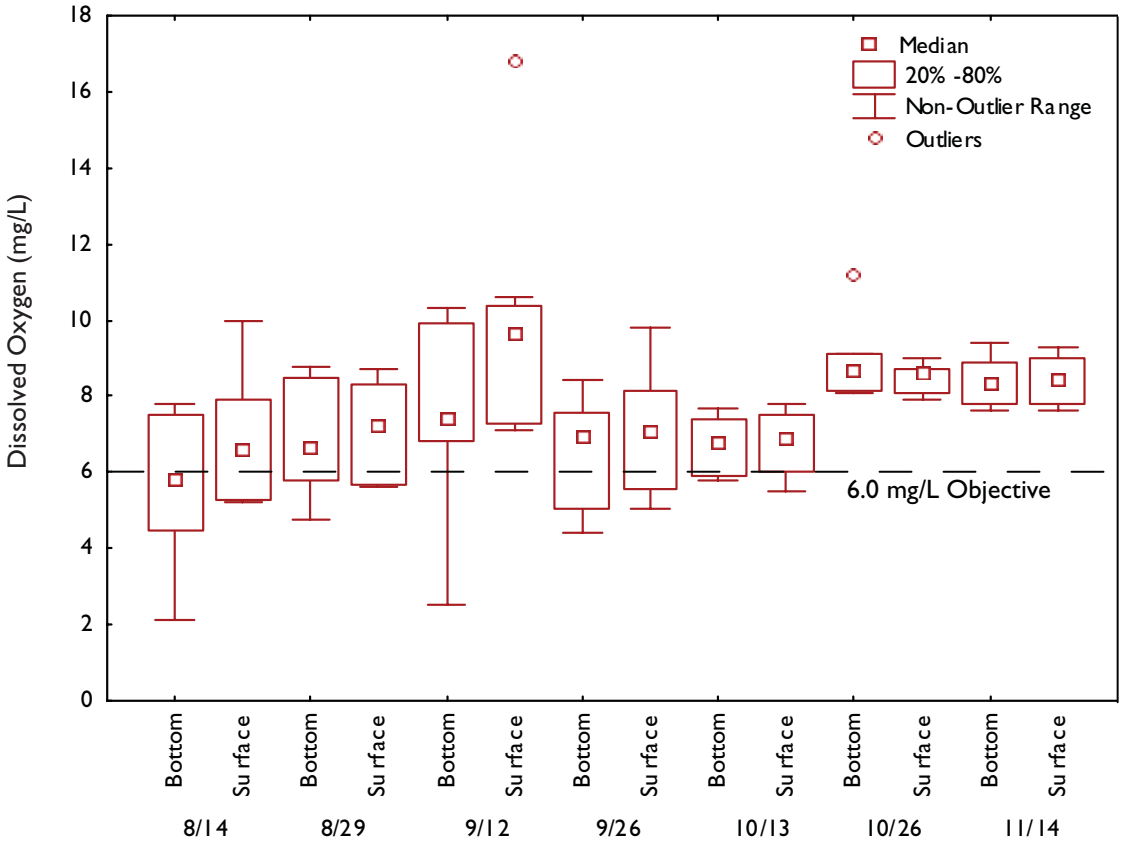


Figure 5-6. Dissolved oxygen concentration in the Stockton Ship Channel, 2000

Port Chicago, is conditioned by the previous month's Eight River Index (PMI) and is noted in Table 4 of D-1641 (Table 5-2). The Port Chicago standard is usually in effect during months when the Port Chicago 14-day EC average immediately prior to the first day of the month is less than or equal to 2.64 mS/cm. If salinity or flow requirements are met for a greater number of days than required for any month, the excess days are applied to meeting the requirements for the following month.

The daily averaged EC for X2 may be alternately met with a 14-day running average of EC for the two locations, or a flow alternative set as a 3-day running average of NDOI for the required number of days. The NDOI requirement is set at 11,400 cfs or 29,200 cfs when the X2 is located at Chipps Island or Port Chicago, respectively. During 2000, PMI for February through June was 2.55 maf, 5.49 maf, 4.08 maf, 3.55 maf, and 3.62 maf, respectively. Using Table 4 in D-1641, the number of days of compliance maintaining a maximum EC of 2.64 mS/cm at Chipps Island was 28 days for February. During March, April, and May compliance was required at Port Chicago for 28, 17, and 6 days, respectively. There were 15 days of X2 requirement at Chipps Island in June.

The X2 Habitat Protection standard at Chipps Island during February was met with the required accumulated number of days of 3-day mean of NDOI greater than 11,400 cfs and days with EC below 2.64 mS/cm. From March through May, the X2 standard was met at Port Chicago using accumulated days of NDOI flows above 29,200 cfs and days with EC below 2.64 mS/cm. June's requirement of 15 days at Chipps Island was easily met with accumulated days 14-day running average of EC below 2.64 mS/cm (Table 5-3).

Table 5-2. D-1641 Table 4: Habitat Protection Outflow

Chipps Island						Port Chicago					
PMI (taf)	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*PMI (taf)*	*Feb*	*Mar*	*Apr*	*May*	*Jun*
500	0	0	0	0	0	0	0	0	0	0	0
750	0	0	0	0	0	250	1	0	0	0	0
1,000	28[a]	12	2	0	0	500	4	1	0	0	0
1,250	28	31	6	0	0	750	8	2	0	0	0
1,500	28	31	13	0	0	1,000	12	4	0	0	0
1,750	28	31	20	0	0	1,250	15	6	1	0	0
2,000	28	31	25	1	0	1,500	18	9	1	0	0
2,250	28	31	27	3	0	1,750	20	12	2	0	0
2,500	28	31	29	11	1	2,000	21	15	4	0	0
2,750	28	31	29	20	2	2,250	22	17	5	1	0
3,000	28	31	30	27	4	2,500	23	19	8	1	0
3,250	28	31	30	29	8	2,750	24	21	10	2	0
3,500	28	31	30	30	13	3,000	25	23	12	4	0
3,750	28	31	30	31	18	3,250	25	24	14	6	0
4,000	28	31	30	31	23	3,500	25	25	16	9	0
4,250	28	31	30	31	25	3,750	26	26	18	12	0
4,500	28	31	30	31	27	4,000	26	27	20	15	0
4,750	28	31	30	31	28	4,250	26	27	21	18	1
5,000	28	31	30	31	29	4,500	26	28	23	21	2
5,250	28	31	30	31	29	4,750	27	28	24	23	3
5,500	28	31	30	31	30	5,000	27	28	25	25	4
						5,250	27	29	25	26	6
						5,500	27	29	26	28	9
						5,750	27	29	27	28	13
						6,000	27	29	27	29	16
						6,250	27	30	27	29	19
						6,500	27	30	28	30	22
						6,750	27	30	28	30	24
						7,000	27	30	28	30	26
						7,250	27	30	28	30	27
						7,500	27	30	29	30	28
						7,750	27	30	29	31	28
						8,000	27	30	29	31	29
						8,250	28	30	29	31	29
						8,500	28	30	29	31	29
						8,750	28	30	29	31	30
						9,000	28	30	29	31	30
						9,250	28	30	29	31	30
						9,500	28	31	29	31	30
						9,750	28	31	29	31	30
						10,000	28	31	30	31	30
						10,000	28	31	30	31	30

[a]When 800 taf <PMI.

Note: Number of days when maximum daily average EC 2.64 mS/cm must be maintained. (This can also be met with maximum 14-day running average EC of 2.64 mS/cm, or 3-day running average Delta outflows of 11,400 cfs and 29,200 cfs, respectively.) Port Chicago standard is triggered only when the 14-day average EC for the last day of the previous month is 2.64 mS/cm or less. PMI is previous month's 8-RI. If salinity/flow objectives are met for a greater number of days than required for any month, the excess days shall be applied towards the following month's requirement. The number of days or values of the PMI between those specified below shall be determined by linear interpolation.

Table 5-3. Determination of Habitat Protection Compliance during 2000

		Compliance					
Month	PMI[a]	Location	Required Days	Days Met	Carryover Days[b]	Criteria Used to Meet Objective[c]	Criteria for Meeting Standard (days met)
Feb	2.55	Chipps Island	28	29	1	3-dm of NDOI>11,400cfs daily mean of EC 14-day mean of EC	26 15 3
Mar	5.49	Port Chicago	28	31	3	3-dm of NDOI>29,200 cfs daily mean of EC 14-day mean of EC	29 29 31
Apr	4.08	Port Chicago	20	21	1	3-dm of NDOI>29,200 cfs daily mean of EC 14-day mean of EC	13 9 10
May	3.55	Port Chicago	9	13	4	3-dm of NDOI>29,200 cfs daily mean of EC 14-day mean of EC	9 5 5
Jun	3.62	Chipps Island	15	18	3	3-dm of NDOI>11,400 cfs daily mean of EC 14-day mean of EC	5 14 18

Note: Shaded area describes which criteria were used to meet compliance days and how many days of each were met.

[a]PMI - Previous month's Eight River Index in maf.

[b]Carryover days may be used to meet the next month's requirement, if at the same compliance location.

[c]Compliance may be met using either daily EC, 14-dm EC <2.64 mS/cm or specific 3-dm of NDOI.

Suisun Marsh Protection Plan and Preservation Agreement

The Suisun Marsh, located in southern Solano County, provides one of the largest estuarine waterfowl habitats in the continental United States and represents more than 10 percent of California's remaining natural wetland habitat. The marsh also provides resting and feeding grounds for thousands of waterfowl migrating on the Pacific Flyway.

Suisun Marsh water quality has been protected since 1971, first through SWRCB's D-1379 and later in 1978 by D-1485. In 1987, the Department signed the Suisun Marsh Preservation Agreement in conjunction with the Bureau, DFG, and the Suisun Resources Conservation District, which represents private landowners. In 1995, SWRCB WR 95-06 eliminated the Chipps Island running 28-day salinity average standard and the Eastern Marsh standard at Mallard.
WR 95-06 added a new narrative objective for the brackish tidal marshes of Suisun Bay to protect remnant tidal marshes and changed the compliance date for two western Suisun Marsh stations, S-35 and S-97, to October 1997. SWRCB granted extensions three times, pushing the compliance requirement to November 1, 1999. D-1641 converted these two western marsh stations to monitoring stations, dropping the compliance requirements at both locations.

The Suisun Marsh Salinity Control Gates began operating in 1989 on an as-needed basis during the control season (from October 1 to May 31) and are operated to meet D-1641 salinity standards. The gates, located 2 miles downstream from Collinsville in Montezuma Slough, respond to daily tidal fluctuations, opening to admit fresher flow from the Sacramento River and closing to block tidal salt-water intrusion from Suisun Bay. The gates are considered to be in full operation when all three gates are tidally operated, the flashboards have closed off the channel, and the boat lock is operational.

During the twelfth control season (October 1, 1999, through May 31, 2000), the gates were operated from September 1 through November 9, 1999, to satisfy the needs of the adult salmon passage study. After the completion of the study, the gates were tidally operated from November 10 to December 9, 1999. Delta water quality concerns resulted in the gates being held open from December 10 through January 16, 2000. From January 17 through February 29, 2000, the gates resumed tidal operations. During the balance of the control season the gates were open and on March 28 the modified flashboards were removed.

During the thirteenth control season (October 1, 2000, through May 31, 2001), the fall 2000 fish passage study was postponed to allow time for further review of past results. As a result, the gates were operated primarily for salinity control. The gates were held open with flashboards removed from October 1 to November 3, 2000, due to good water quality conditions in the marsh. Salinity began increasing during the latter part of October; consequently the flashboards were installed and the gates were placed into operation on November 4 and continued through mid-May to control salinity levels. From May 14, 2001, through the balance of the control season, gate operations ceased and the flashboards were removed as salinity levels improved.

All Suisun Marsh salinity standards were met during 2000 (Table 5-4).

Table 5-4. D-1641 Suisun Marsh Salinity Standards in Effect during 2000

Month	Standard MHTEC[a]	Actual MHTEC[a]				
		C-2 Collinsville	*S-64 National Steel*	*S-49 Beldons Landing*	*S-42 Volanti*	*S-21 Sunrise Club*
			Twelfth Control Season			
January	12.5	6.5[b]	7.4	9.9	11.2	12.2
February	8.0	5.4	6.0	8.2	9.4	11.0[b]
March	8.0	4.5	5.1	7.0	8.0	9.3
April	11.0	3.8	4.6	6.3	7.2	8.3
May	11.0	3.4	4.1	5.9	6.5	7.4
			Thirteenth Control Season			
October	19.0	8.3	13.4	15.8	15.6	15.9
November	15.5	8.9	11.3	13.5	13.6	14.5
December	15.5	9.4	10.4	12.1	12.6	13.4

Note: Additional stations S-35 and S-97 converted to monitoring stations with the adoption of D-1641.

[a]MHTEC - Monthly average of both daily high-tide ECs in mS/cm.

[b]EC value estimated. No data available due to equipment failure.

Bay-Delta Plan Brackish Tidal Marshes of Suisun Bay Narrative

The Bay-Delta Plan's narrative water quality objective for brackish tidal marsh protection is stated as:

> Water quality sufficient to support a natural gradient on species composition and wildlife habitat characteristic of a brackish marsh throughout all elevations of the tidal marshes bordering Suisun Bay shall be maintained. Water quality conditions shall be maintained so that none of the following occurs: (a) loss of diversity; (b) conversion of brackish marsh to salt marsh; (c) for animals, decreased population abundance of those species vulnerable to increased mortality and loss of habitat from increased water salinity; or (d) for plants, significant reduction in stature or percent cover from increased water or soil salinity or other water quality parameters.

SWRCB determined that implementation of Bay-Delta Plan numerical objectives, particularly NDOI, would achieve the narrative objective. In the future, the Department and the Bureau will review and replace the narrative objective with Suisun Marsh Ecological Workgroup recommendations. During 2000, SEW completed its final report. The report was reviewed by IEP and will be submitted to SWRCB in January 2002.

The Suisun Marsh is a mosaic of seasonally managed wetlands, unmanaged tidal wetlands, bays, and sloughs bordered by upland grasslands.

Western Delta Municipal and Industrial Users Agreements

Several contracted water quality standards are in effect for western Delta municipal and industrial water users that predate D-1485 and subsequent water rights decisions and plans. Under agreements with both municipal and industrial contractors, loss of offshore water is compensated for by substitute water supplies, net credit balances for days of above-average water, or monetary payment.

The Department contracted with the Contra Costa Water District in 1967 and with the City of Antioch in 1968 to assure the water district and the city would be compensated for costs associated with the loss of usable offshore Delta water supplies resulting from SWP operations. Credit for the number of days of above-average offshore water supplies of sufficient quality is accrued to offset the number of below-average days in future years. Contra Costa's standard is for 142 days and Antioch's is 208 days of usable water. During water year 2000, a usable Delta water supply was available to Contra Costa and Antioch throughout the period of standard and no compensation payments were necessary.

ERRATA SHEET

for Appendix E to Bulletin132-00

The figure below replaces Figure 4-8 in Chapter 4, page 34 of Bulletin 132-00 Appendix E.

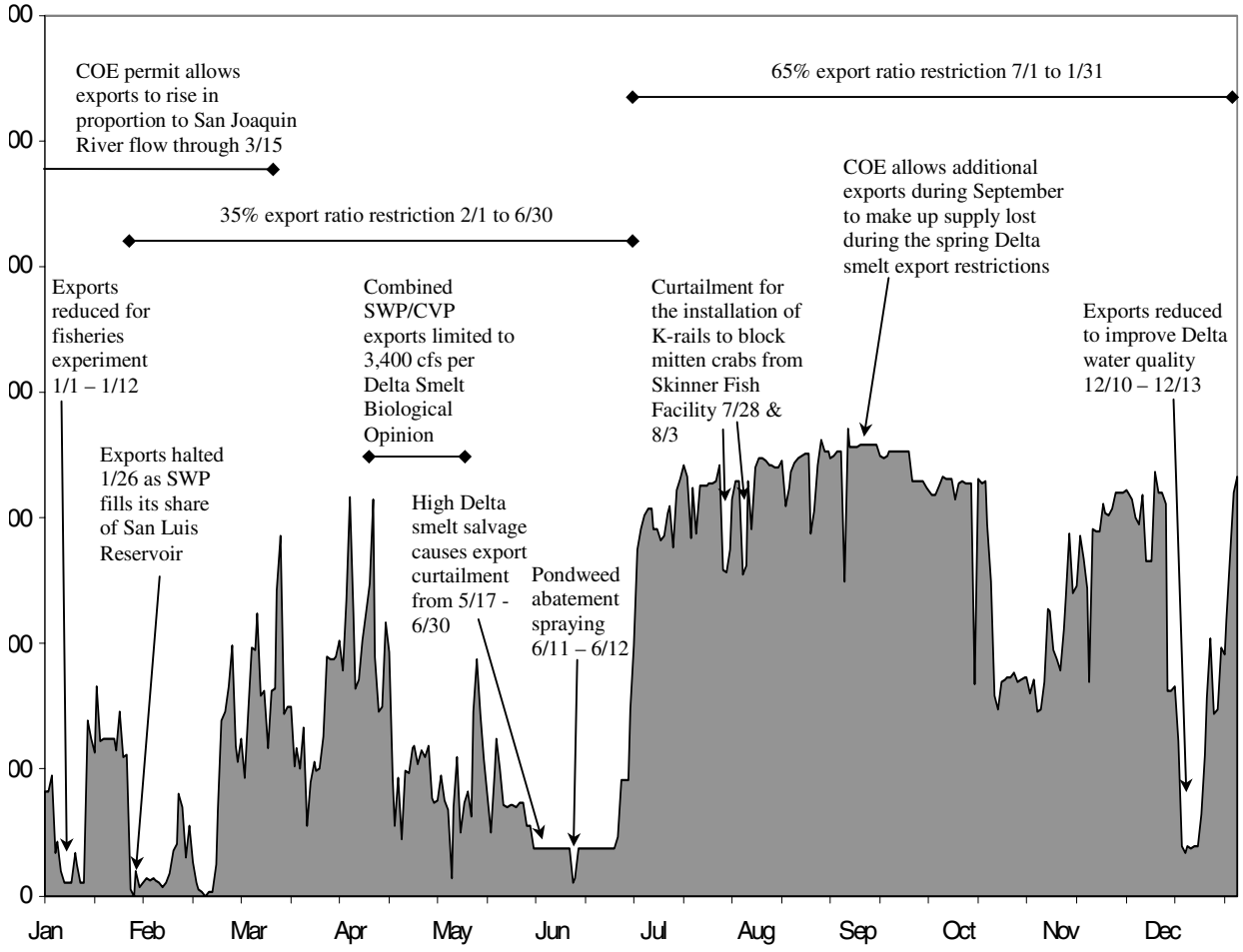


Figure 4-8. State Water Project Delta exports during 1999 (annotated with significant factors affecting exports).